SCIENTIFIC AMERICAN

RIPPING AWAY THE OVERBURDEN WITH A GIANT HYDRAULIC JET.—[See page 154.]

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Kammerlingh Onnes, the Dutch Specialist in Cold

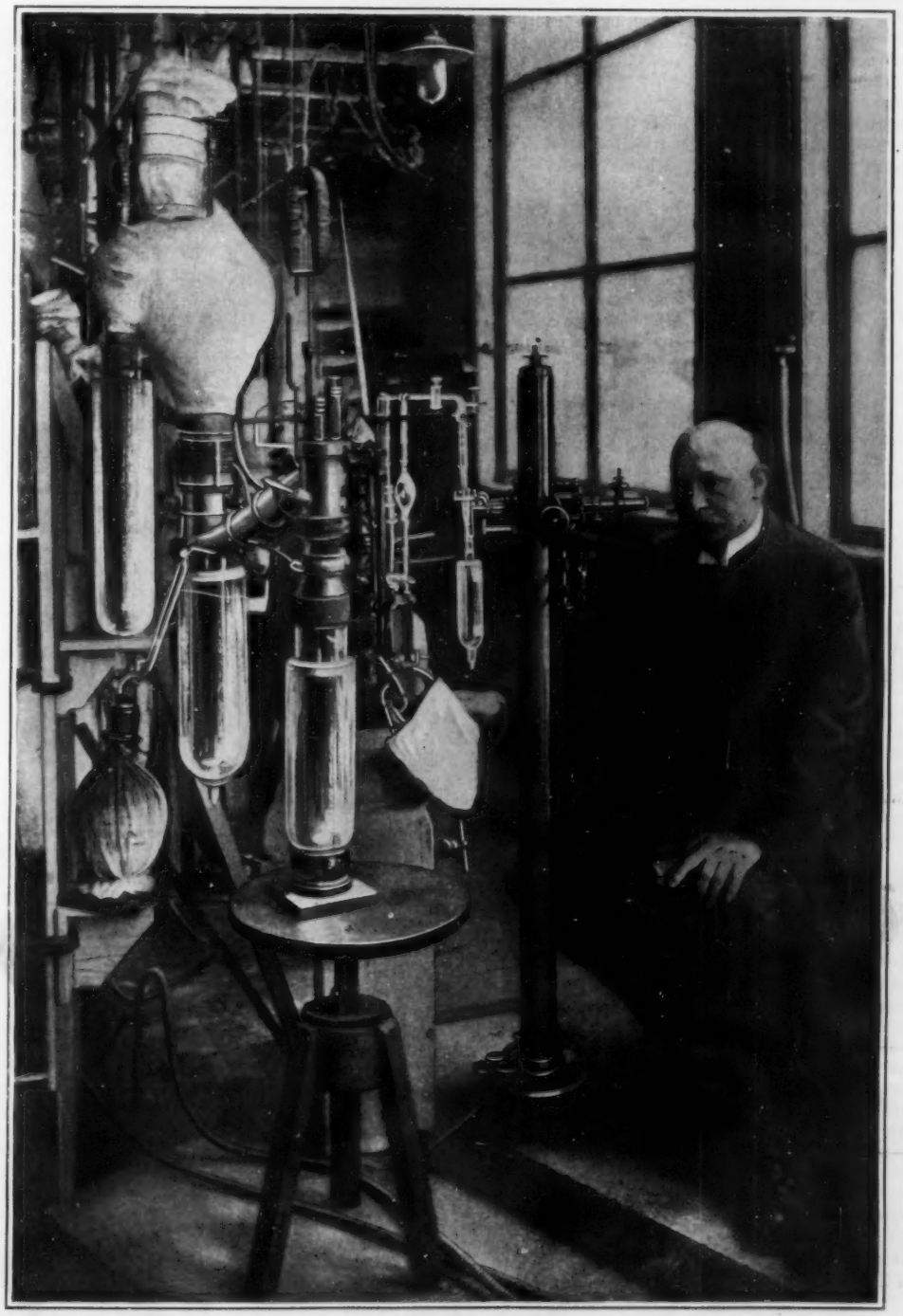
IN the issues of the SCIENTIFIC AMERICAN and SCIENTIFIC AMERICAN SUPPLEMENT of August 29th, 1914, there were presented accounts of the work at the Cryogenic Laboratory, which is experimenting with very low temperatures, those of liquid hydrogen and helium, of which Heike Kammerlingh Onnes is director. The institution is a division of the Laboratory of Physics of the Royal University of Leyden in Holland. The account in the SUPPLEMENT treats specifically of the work of the laboratory, using material that is still in manuscript or thesis form. It is the intention here to speak of Onnes himself, who is not only the leader in a new department in science, but who has created the department, which includes in its investigations some of the most interesting researches of modern times.

Everyone has heard of liquid air and liquid hydrogen, helium, neon, argon and other gases, and of the solidification of some of them. It is this region of science that Onnes has chosen for his field, and here he has erected for himself and for his university a monument that may well be regarded with pride by his countrymen, celebrated as they are for remarkable investigations. The institution is unique and in a new niche in science, so new that a new word has been coined to describe it, Cryogenic. The root, $K\rho\upsilon^{\circ}o\varsigma$, meaning very cold, is familiar to everyone in the word, crystal, which is a cold form of matter, while students in the high schools will have seen the mineral, Cryolite, which suggests ice and cold in its form, and will perhaps remember the cryophorus, a little instrument of glass with liquid in two bulbs. When one bulb is held in the hand the liquid is driven into the other one by the bodily heat, and as it goes it leaves behind it a very distinct sensation of cold in the palm of the experimenter.

Heike Kammerlingh Onnes was born in Groningen, Holland, September 2nd, 1853, and has spent his life within the limits of that kingdom. He has come to public attention within half a year as the recipient of the Nobel prize for physics. He was a student at Groningen University, receiving the degree Ph.D. in 1879, being at the time assistant in the Polytechnicum at Delft. In 1881, two years following his postgraduate work, Onnes was called to the chair of physics at the University of Leyden, and he is there to-day.

Within two years of his installation as professor of physics, Onnes began his studies of very low temperatures. His reason for selecting this he states himself in the "Abstracts" published by his department. He says: "For ten years I have bestowed all my available time upon an investigation of the manipulation of condensed gases in order to make physical experiments on liquid baths of the very lowest temperatures possible," and in further description he notes that "I was induced to experiment with the condition of gases by the study of van der Waal's law of corresponding states." A little further light is shed on the origin of the researches by the friend and fellow worker of Onnes, Prof. Crommelin, conservator of the Physical Laboratory, who notes that most of the proper ties of substances depend upon thermal molecular activity, and that this becomes weaker at low temperatures. The activity gives rise to some phenomena, and these oftentimes obscure what it is desirable to observe. At low temperatures, therefore, when the activities are slight, there are more favorable opportunities to observe the behavior of the bodies themselves.

In 1894 Onnes describes his infant laboratory, and in excusing its smallness says that only a little of the funds of the Physical Laboratory could be afforded for its maintenance. In later years there has often been mention of its growth, but this in a very modest way, so that public attention has not been drawn to it, and it is most probable that the account of it in the SUPPLEMENT of August 29th is the first of the kind in English.



Prof. Onnes in his laboratory at Leyden.

The modesty that has characterized the announcements of the Cryogenic Laboratory is characteristic of the man, Onnes, and this explains why, when the notice was given last winter of the Nobel award to him, there was no one in the popular world who knew about him. The newspapers of two continents had hardly more than a perfunctory notice, while the Who's Who upon which the press leans very much in personal matters, gave him scant space. The English one had but four lines of biography in 1913, with a single accomplishment credited to him, "The liquefaction of helium." The German one was quite as laconic, while the French, "Qui êtes vous?" makes no mention whatever. By the same token he is not on the roll of complimentary membership of the American Academy, although this society is pretty wideawake in honoring foreign special workers in science.

The larger principles of laboratory policy were presented in the SUPPLEMENT article, and it will here suffice to take up the general lines of investigation which this remarkable man has pursued. As early as 1894, when the laboratory began to publish its "Abstracts," Onnes had printed two papers on methylchloride, which were toward making practical its use as a refrigerant, and in 1896 he presented "Remarks on the Liquefaction of Hydrogen." Then his attention was diverted for a moment to the technique of his work, and he invented a method for illuminating the scales of the instruments that were to be read by reflection, and in 1896 devoted considerable time to the adapting of manometers to the special work of measuring pressure of gases at low temperatures. The field was a new one and the way had to be felt out. It was necessary to invent new methods, to devise new instruments, and these were developed as lower and lower temperatures became more practicable. About this time the need of a name for the kind of investigation was evident, and the word, Cryogen, first appears in print.

For the ensuing ten years gases, conditions of gases, and measurement of gases at low temperatures constituted the principal work of Onnes. Then there came the testing of glass for apparatus, and presently magnetism came into the field. Then work on the thermometry of gases and ever and anon the return to the fundamental proposition, the law of van der Waals.

In 1907 fourteen papers are credited to Onnes, with more than half as many more with collaborators, and this comes to another and a very important matter developed by Onnes, the placing of his personal stamp on all the investigations in the new science. The policy of

(Concluded on page 164.)

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The Editor is always glad to receive for examination illustrated, articles on subjects of timely interest. If the photographs are *sharp* the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Problem of the Slides at Culebra

IF, in the construction of a highway, it became necessary to make a cut through a huge dump which had been formed in depositing the excavated material from some large engineering work, the road-builder would encounter conditions broadly analogous to those which exist on the Panama Canal at Culebra. Let us suppose that the dump consisted of clay, earth, and soft rock interspersed with boulders of large size, and that in opening the cut this miscellaneous material had to be cut through. The contents of the dump, before the cutting commenced, would be in a state of equilibrium and the various materials would overlie one another in strata or masses, at various angles and in a condition of great confusion.

As soon as excavation commenced, the equilibrium of these masses would be disturbed. Where the material encountered was loose in character and possessed but little cohesion, it would tend to slide into the cut until the sides had assumed various angles of repose corresponding to the natural slope of that material. It is conceivable that if the dump had been formed many years before operations commenced, some of the material, such, for instance, as the clay and the mud, having solidified, would stand up, when it was first exposed, at an angle or slope which that material could not maintain after it had been subjected to the influence of the weather. There would be a general disintegration; cracks would open some distance back from the edge of the cutting; and there would be a vertical subsidence and a lateral flow of the material, tending to fill up the cutting. Where huge boulders had been blown into the original dump, or masses of broken rock were encountered, the sides of the cutting would probably stand at the angle determined upon. Broadly speaking, the conditions of the equilibrium assumed by the materials in the dump when it was first made, would be destroyed by the opening of the cut, and it would have to be left to the operations of the laws of gravity, frictional resistance, etc., to determine the time necessary for the walls of the cut to reach a permanent slope.

Now, speaking very broadly, it may be said that conditions at the Culebra cut are analogous to those in our supposed cutting through a dump which had been long enough in existence to have reached a condition of repose. The Isthmus of Panama consists of a mixture of volcanic and marine-deposited material, the latter consisting of the usual silt which in the course of ages accumulates on the bottom of the ocean. Originally, this marine deposit lay in fairly parallel and level strata above the underlying rock. Gradually the whole mass was raised by volcanic action above the level of the surrounding ocean until the Isthmus of Panama was formed. Subsequent volcanic action, resulting in upheaval, caused the igneous rock to be thrust up in places through the overlying marine-deposited material. This upheaval was very irregular, and consequently the overlying mass of softer stuff has been thrown into all manner of confused and more or less broken strata, through which, in such places as Gold Hill, the volcanic rock protrudes.

Now, this confusion would not have been so serious a matter for the construction of the canal, had the whole of the Isthmus been geologically older than it is, and had the softer rock had sufficient time to become thoroughly hardened and solidified. As matters stand, it has been found that wherever the volcanic rock is encountered or wherever the depth of the cut is not too great, the sides of the cut stand at the angle determined upon by the engineers when the plans of excavation were drawn up. But in the deep cutting through the divide at Culebra, the softer material has persistently refused to stand at the arbitrary slope determined upon by the engineers, and has shown a disposition to keep sliding into the canal or breaking away in vertical sections, until a much flatter angle, corresponding to the angle of repose of the particular material at the place of sliding, has been reached.

When water was first turned into the canal it looked as though conditions of equilibrium had been reached, or approached, throughout the whole of the Culebra cut; but subsequently, serious slides have developed on each side of Gold Hill, which forms the ridge of the mountain divide and is the deepest point of excavation throughout the canal. The first great slide was a recrudescence of the activity at the old Cucuracha slide to the south of Gold Hill. The present slide exists in the soft material to the north of Gold Hill. It is a slide of well-recognized character and it presents no novel difficulty—its removal is merely a matter of time and patience.

In a recent interview, Colonel Goethals informed us that the break, about 2,000 feet in length, has occurred about 250 feet back of the edge of the bank at a point where the latter is 250 feet in depth. This mass has settled vertically, and the foot of it has crowded into the canal. At the present time, of this 2,000 feet only 200 feet is giving any trouble. Here the powerful dredges have opened out a channel which is constantly increasing in width and depth. The material of the slide is being taken through the canal to Gatun Lake and there dumped, the work of removal being done at the low cost of 35 cents per cubic yard. According to Colonel Goethals, no new problem is involved in the present trouble, or as he expressed it, the conditions call, more than anything else, for steady dredging and patience.

Is There Any Defense Against the Submarine?

IF we may judge from the number of queries that come to this office, the most interesting technical question of the war, just now, in the minds of the American public, is whether there is any possible means of defense against the submarine. The present article is an attempt to answer this question.

In the first place let it be accepted, once and for all, that if a submarine, and particularly one of the German type, can get within point-blank range of the enemy, the ship attacked will either be sent to the bottom or its days of military usefulness will be over for many a long month to come. One of the most striking evidences of German forethought was their designing of a special type of submarine torpedo, having a limited range of only 1,200 yards, but carrying no less than 420 pounds of high explosive in the warhead. The fact that every warship which has been struck by German submarine torpedoes has gone to the bottom, is conclusive evidence of the terrible efficiency of these weapons.

Protection against the submarine may be sought both in the defensive and offensive direction. One of the principal efforts of naval constructors for many years past has been to afford such effective defensive protection, by means of extensive subdivision below the waterline, that the inflow of water from a torpedo explosion would be limited—so limited, in fact, that the ship would remain afloat and proceed to port under its own steam. The rapid sinking of the "Aboukir," "Cressy," "Hogue" and "Formidable," and later of the "Audacious" (which, even if it was struck by a mine, received a blow but little greater, probably, than that delivered by the German submarine torpedo), has shown beyond all disputation that the submarine, if it once gets within effective range, has the mastery even of the most modern and largest of warships. It is our opinion that, no matter to what extent subdivision may be carried or how great a part of the displacement is sacrificed to torpedo-defense cofferdams or compartments—in view of the increasing size of the submarine, its increasing speed, and the possibility of a yet further increase in the explosive charge of its torpedoes, it will be impossible to render the warship of the future safe or even reasonably protected against submarine attack.

The speed of the submarine is generally so low as compared with that of modern warships, that the chances of its getting within firing range are very much smaller than the average layman would suppose. One of the principal lessons learned in this war is that high speed and quick maneuvering of the ship attacked, combined with a sharp lookout from the masthead, are a most effective protection. In calm weather, when the sea is fairly smooth, the course of the periscope of a submarine is clearly discernible by the long white streak of broken water which it leaves behind. Naval men will tell you that, even when the periscope itself is submerged, there is a certain disturbance of the surface of the water, indicating the presence of a moving submerged body.

When a dreadnought, battleship, or armored cruiser of first-class importance is steaming in submarine-infested waters, it should always be accompanied by destroyers, which have proved, in the operations in the North Sea, that they can "go" for a submarine with all the snap and dash of a terrier after a rat. There have been several cases of successful ramming of submarines by destroyers, and one or two fairly well authenticated cases of the submarine being sunk by gun-fire as it came to the surface for observation.

The difficulty of detecting a submarine increases as the water grows rougher, and it will be remembered that the most successful attacks on large ships have been made in stormy weather, notably in the case of the "Formidable." The wash of the periscope then becomes very difficult to detect.

By far the most hopeful method of protection against this insidious form of attack is to be found, strange to say, in a new form of naval warfare and observation, the dirigible and the aeroplane. Experiments by our aviators during the occupation of Vera Cruz and at other points have shown that it is possible to detect a submarine, when the observer is two or three thousand feet in the air, at depths below the surface of the water which are positively surprising, the submarine being visible in clear and calm water at a depth of fifty to one hundred feet. Now, a submarine which is contemplating an attack has to keep pretty close to the surface so as to "porpoise," as it is called, swiftly and frequently, to take a periscopic peep at the enemy. In rough water vision is not so good, but the submarine can still be seen. Now here is a means of defense, the importance and possibilities of development of which can scarcely be overestimated. A squadron of aeroplanes thrown out in reconnaissance ahead of the fleet would, in any but thick or stormy weather, be an admirable defense against an enemy which "needs only to be seen" to be laughed at.

Regarding the submarine attack on merchant ships in the Irish Sea and elsewhere, it has to be admitted that such vessels are practically defenseless unless they keep a very sharp lookout and are able to show a clean pair of heels to the enemy, which only the faster ships can do. Just now, the development of this form of attack and the question of how it will be met, is one of the most interesting problems of the war.

The Universal Distrust of the Shipping Bill

EVERY day brings additional evidence that the sentiment of the country is against the Government Ship Purchase and Ownership Bill. Most significant, because of its widely representative and highly authentic character, was the recent vote against the bill at the gathering in Washington of the Chamber of Commerce of the United States of America, which put itself on record as opposing the measure by a vote of 163 to 90. And this vote, be it remembered, was cast in spite of the fact that Secretary of the Treasury McAdoo delivered at the meeting a most able speech in support of the measure. The New York Chamber of Commerce, equally emphatic in condemnation, has sent out a strong circular against the bill; and, as we go to press, we have received the following letter from Mr. Winthrop L. Marvin, a high authority on the merchant marine, whose articles on this subject in the SCIENTIFIC AMERICAN of October 3rd, 10th, and 17th of last year will be fresh in the minds of our readers.

Mr. Marvin writes:

"Your editorial admirably reasons out the case of the people against the ill-advised bill for Government purchase, ownership, and operation of merchant vessels. As I write, a large gathering of representative business men of Boston, of both political parties, in Faneuil Hall, has unanimously adopted resolutions condemning the measure as a long step toward socialism and a peril to our flag. One of the speakers, Mr. Elwyn G. Preston, representing the Chamber of Commerce, said that a Boston company that had just laid down two new ships, of 8,500 tons, would have ordered six ships but for the measure pending in Washington.

"It is manifest to all who live near the sea and have any familiarity with ocean trade that instead of increasing, this ill-starred scheme will reduce the facilities available for the carrying of our commerce. The Administration and Congress lost a great opportunity last August when they failed to take some real emergency step at the very outbreak of the war.

"An offer, then, of a fair compensation adequate to cover the difference between the cost of operation of American and foreign ships would have encouraged the immediate building in American yards of a fleet of cargo steamships, designed for auxiliary naval service as fuel and supply ships in time of war.

"If those ships had been started last August they could have been completed a few months hence. They would have meant a real and valuable addition to our shipping resources for the export of cotton, grain, and provisions. Their nationality would have been unquestioned. We should not be 'buying a quarrel' with these real American ships.

"For this deplorable failure to act with vigor, courage and patriotism, President Wilson and Secretary McAdoo are primarily responsible. No fatuous Government ownership scheme would have been pressed but for their insistence. The American people have a right to ask why this was so. No answer has yet been given."

Notes on the War

The Future Submarine.—We do not know of any branch of naval construction more full of promise to the skilled inventor than that of the submarine. There is a call for lighter but more powerful motors, and for greater endurance and speed in the submerged condition. There is a demand for periscopes with a larger and clearer field, that can be operated from greater depths; instruments which will enable observation to be made at depths that would avoid all surface disturbance of the water, save by the periscope itself.

Impossible to Break Through.—One of the principal causes of the present deadlock in the western theater of war is the strength of the field artillery coupled with the fact that the terrain back of each line is carefully mapped out for artillery fire, the distance of each square or section from selected battery positions being accurately known. Should a massed attack of the enemy break through in strong force, the troops would find themselves exposed to shell and shrapnel fire of such accuracy and volume that they would be decimated. Without underestimating the value of rifle-fire and the bayonet, it may be said, with fair approach to the truth, that the field gun and the howitzer completely dominate the situation.

German Warships Still at Large.—In spite of the sweeping operations of the combined British, French and Japanese navies, four of the armed ships of the Germans are still at large. The fast cruiser "Dresden," which escaped from the battle off the Falkland Islands, is supposed to be somewhere in the Pacific, where also the auxiliary cruiser "Prince Eitel Freidrich" was last reported. In the Atlantic (presumably in the West Indies or somewhere on the northeast coast of South America) are the fast cruisers "Karlsruhe" and the auxiliary cruiser "Kronprinz Wilhelm." Since most of these vessels have recently made no captures, or none that have been reported, it is presumed that they are in hiding in sheltered bays or possibly, like the "Koenigsberg," in some river difficult of access or observation.

Aircraft on the Battle Line.—From the "recent notes by an eyewitness" with the British General Headquarters in France, which, by the way, are admirable instances of lucid writing, we quote the following: "There are, generally speaking, two kinds of reconnaissance, whether executed by aviators or cavalry—tactical and strategical. It is difficult to draw a hard and fast line between them, or to define exactly where one begins and the other ends; but the former may be said to be undertaken exclusively for the purpose of ascertaining the strength and disposition of the enemy in a strictly limited area along the battle front, by locating and examining his trenches, gun emplacements, headquarters, reserves, supply parks, and rail-heads. Its sphere ceases at a comparatively short distance in the front of the opposing forces. All that is going on in the area far behind the enemy's line comes within the sphere of strategical reconnaissance."

Attack of Coast Fortifications from the Land.—All the guns, big and little, in the coast defenses of the United States point seaward. The parapets, redoubts, etc., which protect the guns are on the seaward side of them. From the rear, these fortifications are completely open to attack; for not a gun points in that direction and the fortifications offer practically no defense from attack by land. We have not enough coast-defense troops to man the batteries; still less have we troops to repel attacks from the land side. If the forts were so taken, the mine-sweeping vessels, being safe from the attack of the rapid-fire guns on the forts, would pass at their leisure through the entrance channels and remove all obstructions. Then our greatest cities could be approached with impunity by the heaviest foreign battleships, which would be free to take up such positions as would best enable them to cover these cities with their guns, and enforce indemnities from the payment of which there would be no escape.

The German Naval 15-inch Gun.—According to an artillery expert writing in a German artillery magazine, the latest naval gun, if the ballistic data which he gives are correct, is a truly astonishing weapon. The gun, presumably of 15-inch caliber, is reputed to fire a shell of over 2,000 pounds weight with a velocity of over 3,000 feet a second. If the Krupps have produced such a piece, they must have developed a gun-steel and a powder altogether superior to that of any other nation, our own included. Velocities of 3,000 feet per second for large guns were tried and abandoned several years ago, because of the severe erosion due to the high powder pressure and accompanying heat. To avoid erosion and prolong the life of the gun, the tendency is to increase the weight of the shell and decrease the velocity, our own 14-inch naval guns having only 2,600 foot-seconds velocity, and our 14-inch army guns only 2,250 foot-seconds. We know that one of the leading naval powers of the world recently offered the Krupp agents a very large and remunerative order for guns of the 15-inch, high-velocity type, if the company would guarantee a certain accuracy life; but the guarantee was refused.

Science

Health Officers for the Country.—A recent article in the Public Health Reports suggests a solution of the problem of securing for the rural community a sanitary service analogous to that enjoyed by cities. The solution is exemplified in the experience of six small neighboring town communities which united in the maintenance of a joint health office, with very satisfactory results. While country life is popularly supposed to be more healthful than city life, the reverse is apt to be the case, owing to the fact that public health is more carefully supervised in cities than in country towns.

"Health News" is the title of a new series of pamphlets which the U. S. Public Health Service is issuing, chiefly as "copy" for newspapers; the object being to secure wide publicity for important matters relating to public health. These pamphlets are prepared by a manifolding process, and have thus far related to such diverse topics as hygiene in rural schools, the Friedmann tuberculosis treatment, prevention of pellagra, poisons and habit-forming drugs, value of mental hygiene in the development of backward children, and a comparison between modern and 16th century methods of treating vessels infected with plague.

The Gyro-compass in the Navy.—Gyro-compasses have now been installed on 20 battleships, 1 armored cruiser, and 15 submarines of the United States Navy, and it has recently been decided to install master compasses in duplicate on all battleships of the "Delaware" class and later. Special attention is being paid to the instructions of officers and men in the care and use of these compasses, by sending them for a month's instruction at the New York navy yard, or at the works where the compasses are made. The Bureau of Navigation also maintains with the Atlantic fleet two chief gunners who have been specially trained as gyro-compass experts, their duty being to inspect and adjust the compasses and give instructions in their use.

The Etiology of Pellagra continues to be one of the most actively discussed questions in medical science. Messrs. Siler, Garrison, and MacNeal have recently published the results of a statistical study of the foods used and the occurrence of pellagra in mill villages including about 5,000 persons. These investigations do not show any consistent relationship between any particular food and the occurrence of the disease. On the other hand, they do show that new cases of pellagra have developed almost exclusively in persons living in the houses where cases had previously occurred, or in houses next door to them, from which it is assumed that pellagra is an infectious disease, though apparently it is not readily transmitted to any considerable distance. Elaborate investigations of pellagra are being carried on in several southern States by the Public Health Service.

A New Race of Pygmies.—The discovery has just been made in the central portion of the French Congo of a race of pygmies hitherto totally unknown. The members of the race are said never to surpass 1.5 meters, about 4 feet 9 inches, in height. According to *La Revue*, they live entirely isolated in the territory of Mongimbo. They build huts of hemispherical shape in the forest in groups of from 5 to 30. The chief is an old man who exercises absolute and hereditary authority and elects his own successor. They follow a curious custom as to food, the women subsisting on edible roots, while the men live on the products of the chase. According to a legend among them, the former are descended from a hedgehog and the latter from a toad. They have vague notions of good and evil and have a certain cult of the dead, whom they inter with much piety. They are valiant in the defense of their liberty and independence.

Nocturnal Radiation from the Earth.—While much attention has been paid in recent years to measurements of the amount of solar radiation received by the earth, at different places and seasons, and under various conditions, there have been comparatively few measurements of another important factor in the thermal economy of the earth; viz., the amount of heat radiated outward by the earth's surface at night. Nominal measurements of terrestrial radiation have generally been limited to the comparison of readings of unscreened minimum thermometers laid on the ground with those of similar thermometers exposed in a screen some feet above the ground. Such observations merely show whether nocturnal radiation has or has not been active, but give no real quantitative values. Since May 14th, 1914, measurements of the loss of heat from a blackened surface freely exposed to the sky at night have been made by the Weather Bureau at Mt. Weather, Va. The maximum rate observed was 0.22 calorie per minute, or 13.2 calories per hour, and occurred on a clear night in early June. The rate has been found to be very uniform during a clear night. If the same rate is maintained during the day, the total radiation from the earth during 24 hours of clear weather in June may amount to 317 calories, or about 40 per cent of the insolation. The average nocturnal radiation in June was, however, less than 60 per cent of this maximum, and continued to fall off as the water-vapor content of the atmosphere increased.

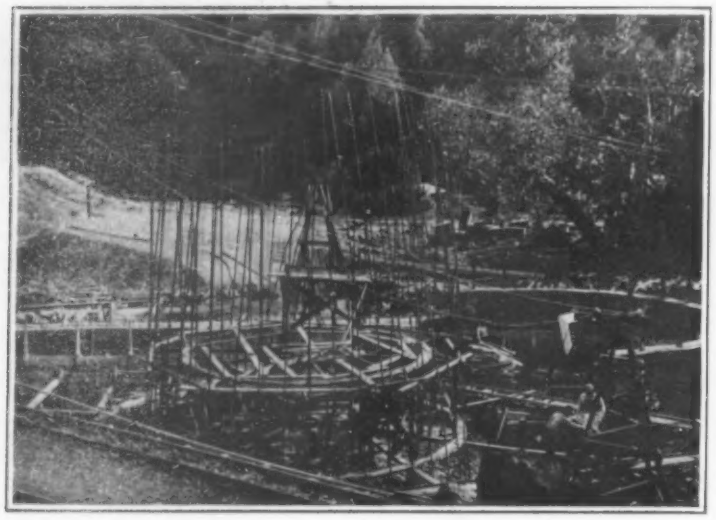
Astronomy

Intensity of the Sunset Afterglow.—In watching the western sky after sunset one receives the impression of an increasing intensity in the rosy glow for a time, followed by a diminution of intensity. This is, however, an illusion, as shown by photometric measurements recently executed by P. Gruner in Switzerland. He found that the glow of the western sky steadily diminishes after sunset, but not at the same rate as the light of the sky midway between the horizon and the zenith. The latter at first decreases more rapidly in intensity than the sunset glow, and then less rapidly. Hence, the apparent increase in the intensity of the sunset glow is an effect of contrast with the illumination of the sky at a distance from the horizon.

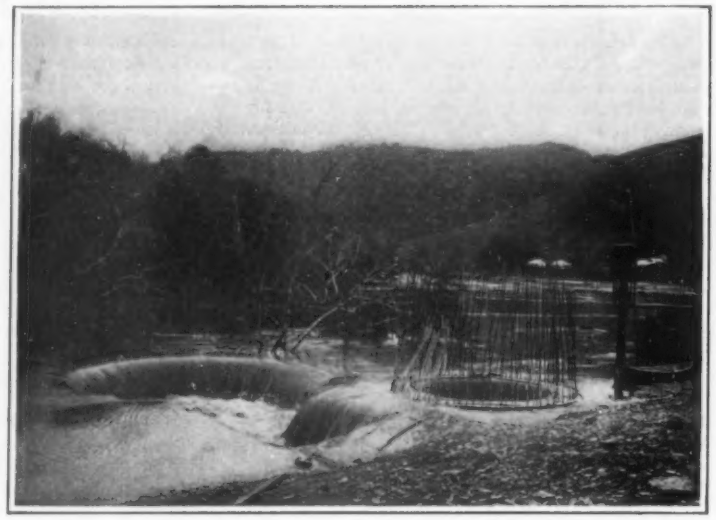
New Stars.—Some of the phenomena presented by so-called "new stars" at a late stage in their history have been recently investigated. It was generally thought that these stars, in their last stages, presented a nebular spectrum, but in 1907 Hartmann directed attention to the case of Nova Persei (1901), the spectrum of which, in its later stages, no longer presented the chief nebular lines. It is interesting to determine whether all novae behave in this manner. As the result of a number of observations it is suggested that this is indeed the case, a close correspondence being pointed out between the stars called Wolf-Rayet stars and temporary stars in the later stages of their history. The hypothesis that the phenomenon of a temporary star is due to a star entering a nebula is deserving of some attention, since the disappearance of the chief nebula lines is coincident with the emergence of the stars from the nebula.

Photographic Telescope for Yale Observatory.—The last annual report of the observatory of Yale University describes the new instrument for parallax investigations now being installed at that observatory to replace the 6-inch heliometer heretofore used for such observations. It consists of a photographic telescope of 15 inches aperture and 50 feet focal length, to be mounted parallel to the earth's axis of rotation. Light from the celestial bodies will be reflected upon the lens from a 30-inch silver-on-glass mirror, carried by an equatorial mounting. This mirror will also direct the rays of light to another lens of 10 inches aperture, mounted close beside the photographic lens and having the same focal length, thus serving as the objective of the guiding telescope. The star images in the field will of course revolve about the axis of the lens, and means have been provided for rotating the photographic plate-carrier at the rate of the earth's diurnal rotation.

Measuring Stellar Radiation.—The development of apparatus for the exceedingly delicate work of measuring the radiation from the stars continues to occupy the attention of the U. S. Bureau of Standards. The latest achievements in this direction are reported by W. W. Coblentz in the *Journal* of the Franklin Institute. He finds that there is little difference in the radiation sensitivity of stellar thermocouples constructed of bismuth-platinum, and those of bismuth-bismuth+tin alloy, which have a 50 per cent higher thermo-electric power. A recent improvement is a method of maintaining a vacuum by the use of metallic calcium, so that the observing apparatus may be taken to the most remote places without carrying along an expensive vacuum pump. Dr. Coblentz has used his instrument in measuring the radiation from 112 celestial objects, including the bright and dark bands of Jupiter, a pair of Jupiter satellites, the rings of Saturn, a planetary nebula, and 105 stars. Its remarkable sensitiveness is shown by the fact that quantitative measurements were made on stars down to the 5.3 magnitude, and good qualitative measurements down to the 6.7 magnitude. It was found that red stars emit from two to three times as much total radiation as blue stars of the same photometric magnitude (i. e., of the same brightness). The principal object of these observations was to ascertain what sensitivity would be required in order to be able to observe spectral energy curves of stars. The present apparatus is so sensitive that, when combined with a 3-foot reflecting telescope, it should give a galvanometer deflection of 1 millimeter when exposed to a candle placed at a distance of 53 miles. It will, however, be necessary to have apparatus about 100 times as sensitive as this in order to do much valuable work on stellar spectral energy curves—and this increase in sensitivity is said to be possible! Such an instrument would be sufficiently sensitive to detect the radiation from a candle placed at a distance of 500 miles, assuming the rays not to be absorbed in passing through the intervening space. The writer also describes measurements made to determine the amount of stellar radiation falling on a square centimeter of the earth's surface. This is so minute that the radiation from Polaris falling upon the area in question would need to be absorbed and conserved continuously for a period of 1,000,000 years in order to raise the temperature of 1 gramme of water 1 deg. Cent.; while that of all the stars would require from 100 to 200 years. The sun's rays are found to furnish the same amount of heat in about one minute.



At work on the upstream end of the storm-water culvert. The gate tower under construction in the foreground.



Flood waters pouring into the intake of the big storm-water culvert leading under the dam.

Hydraulic Fill Dam for an Earthquake Region

Work on the Calaveras Reservoir of the San Francisco Water Supply

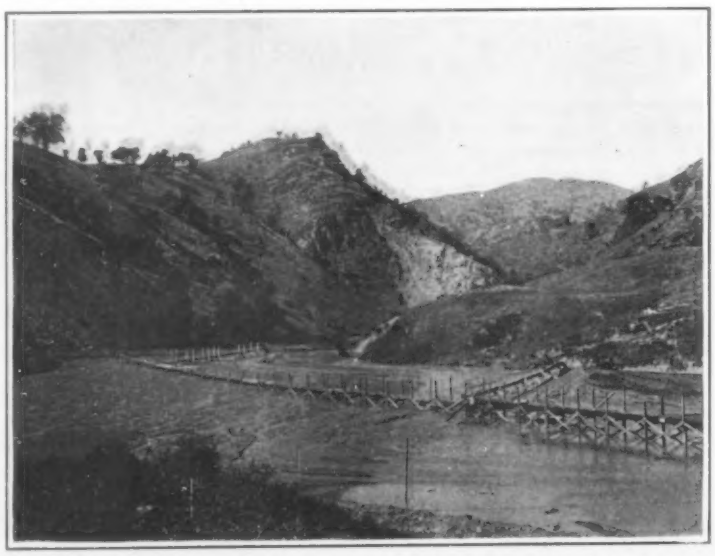
AT the time of the great San Francisco earthquake of 1906, the San Andreas rift, with a lateral movement of eight feet, passed through two dams without doing any damage. Had the dams been of concrete, undoubtedly they would have been shattered and would have plunged a flood upon the surrounding country. But they were made of earth, and yielded to the quaking without parting. In regions subject to seismic disturbances this is the only safe type of dam to build. Thus, at the Panama Canal we have, in place of a concrete barrier, an enormous hill of earth to retain the waters of the big Gatun Lake. A similar dam on a smaller scale is now under construction at the Calaveras Reservoir, about thirty-six miles southeast of San Francisco, where a mountain stream, which in time of storms swells to torrential proportions, is being dammed to provide a reservoir that will augment the water supply of San Francisco. The dam will rise 220 feet above the bed of the stream or 240 feet above bed rock. It will be a quarter of a mile wide at the base, or 1,312 feet, to be exact, tapering to a width of 25 feet at the crest, while its length at the crest will be 1,250 feet. Altogether there will be 3,100,000 cubic yards of material in the dam. The upstream face of the dam will be paved with concrete.

Owing to its enormous size, several years will be required to complete the work, and the matter which called for immediate attention on the part of the engineers was a means of passing the flood waters during the period of construction. The first work consisted in diverting the stream from its bed by means of a temporary dam and a waste flume running along the hillside. The capacity of the flume was sufficient to carry off the summer flow. This done, work was immediately started on a storm culvert a quarter of a mile long, running down the bed of the stream from the upper toe through the entire dam site. This culvert is of horseshoe shape with a cross-sectional area equivalent to that of a circle twenty feet in diameter. The first work consisted in placing the invert of the culvert, in which operation movable concrete mixers were employed. Twenty-six thousand two hundred and forty cubic yards of material were excavated for the culvert foundations, and in order to keep bed rock contact and retain grades, the invert was in some places 12 feet thick.

One of our photographs shows the work on the invert, while another shows the operation of building the arch. To prevent seepage along the conduit it was formed with "collars." The work was pushed with all haste during the time of low water, and was brought to completion in less than four months. For a large part of the time two ten-hour shifts were worked. The average amount of concrete laid per shift was 120 cubic yards, with a maximum of 400 cubic yards. Altogether 19,987 cubic yards of concrete was laid in the construction of the culvert and its appurtenances. At the entrance to the culvert there is a low circular weir 40 feet in diameter which may be raised by flashboards, when desired, to regulate the depth of the pond above the dam for hydraulic operation, in time of small flow.

The sluicing operations with which the dam is being built are of considerable interest. To prevent seepage under the dam, the overburden was removed, exposing bed rock for a strip 140 feet wide along the center line of the dam. All excavated material was placed in the upstream toe to form a barrier across the channel and divert the flood water through the culvert. Directly under the crest of the dam, a cut-off trench 25 feet wide and 8 feet deep was excavated, and as the work of filling the dam progresses, this cut-off trench is being carried up the sides of the canyon. The material placed in

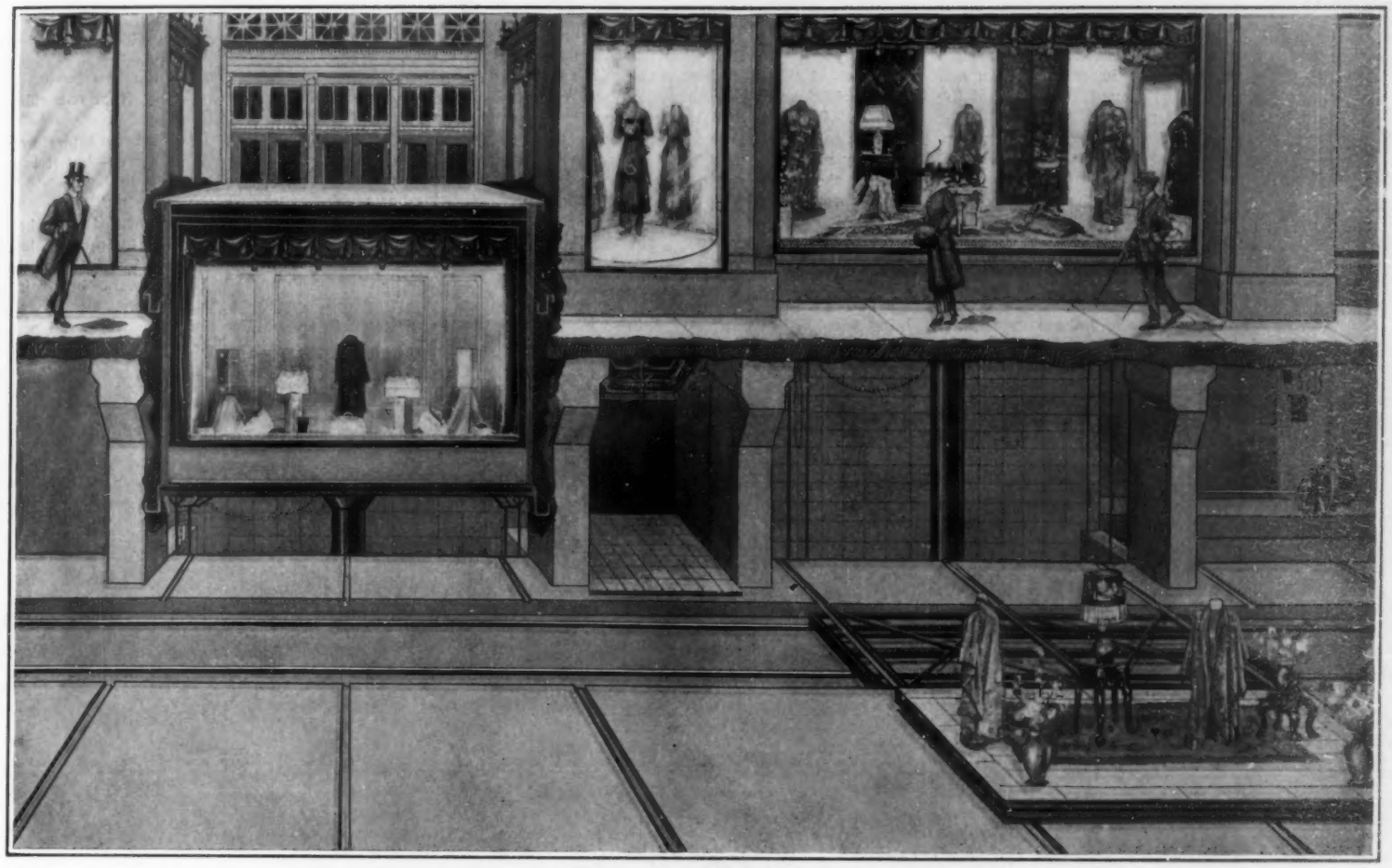
(Concluded on page 164.)



Discharging hydraulicked material at the downstream toe of the dam.

Forming the arch of the culvert. Note the "collars" to interrupt seepage.

Laying the invert of the storm-water culvert with a movable concrete mixer.



Elevator show window system, showing how the store entrance is closed at night by a display case.

Using a Store Entrance for Night Displays

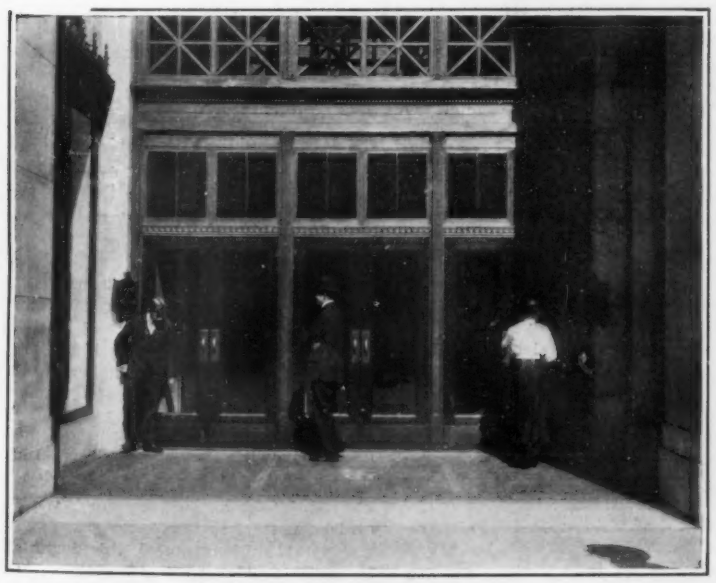
Elevator Show Windows That are Dressed in the Basement

"A WINDOW display on Fifth Avenue is worth more than a page advertisement in all of the city's daily papers," said the buyer of a large New York department store, recently. He found that although such a display was not seen by so many people, it actually sold more goods. The window display is more in the nature of a class advertisement, because it is seen by those who are out to buy, and are interested in the very things exhibited in the show window. In addition to this it has a decided advantage over the advertisement in a daily paper. It requires a certain mental effort to construct from a word description and a black and white illustration a visual image of the goods that are for sale, and the appeal, no matter how cleverly worded, depends after all upon the ability of the reader to visualize the advertisement. In the show window, on the other hand, the goods are to be seen in actual life, in proper surroundings, in attractive settings and in a color scheme that it is impossible to reproduce in a newspaper.

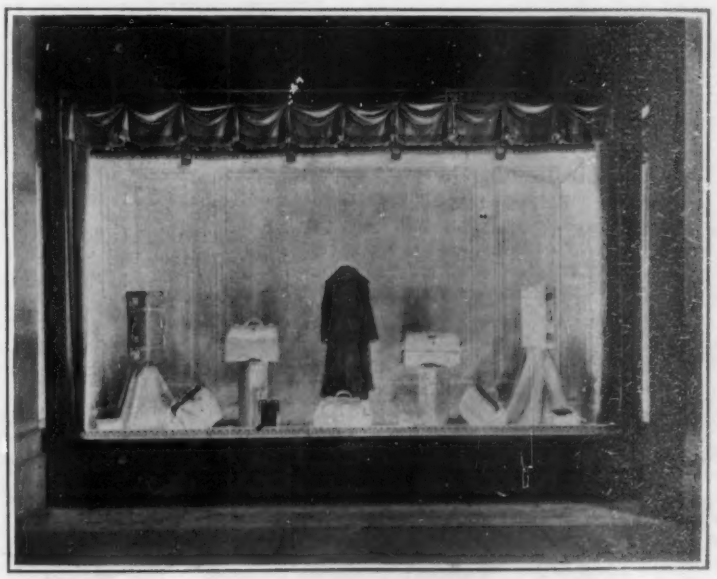
So valuable has show-window advertising become that even the space given up to the entrance of a store is begrudged. One of the latest of New York's Fifth Avenue stores, that of the firm of Lord & Taylor, actually uses the entrance for display purposes. During the day there is absolutely nothing to betray the novel construction of the open vestibule. But at the close of day, when the entrance is no longer of any use to customers, passersby may see the floor of the vestibule begin to rise and presently a completely dressed show window emerges from the basement and lines up with the rest of the windows. And during the evening pedestrians gaze at an unbroken row of show windows, and unless they know what has been done are puzzled at not finding the slightest evidence of an entrance anywhere. The vestibule showcase remains in position until well into the night, when the deserted avenue renders it no longer of any advertising value. Then it is lowered to permit of sweeping the entrance, cleaning the plate glass of the doors and polishing the brass work. Thus everything is prepared for the business of the following day, and in the morning customers enter the store oblivious of the fact that they are walking on the roof of a show window.

At the bottom of this page are two photographs taken from exactly the same spot, one of them exposed during the day time and the other at night with the show window in place. This illustrates how completely the entrance is transformed. The manner in which this is done is shown in the accompanying drawing, in which the entrance showcase appears in the act of being raised. A hydraulic plunger elevator is used for the purpose.

A difficulty that the architects had to contend with



Day view. The floor of the store entrance is the roof of a show window.



Night view photographed from the same spot. The show window completely hides the entrance.

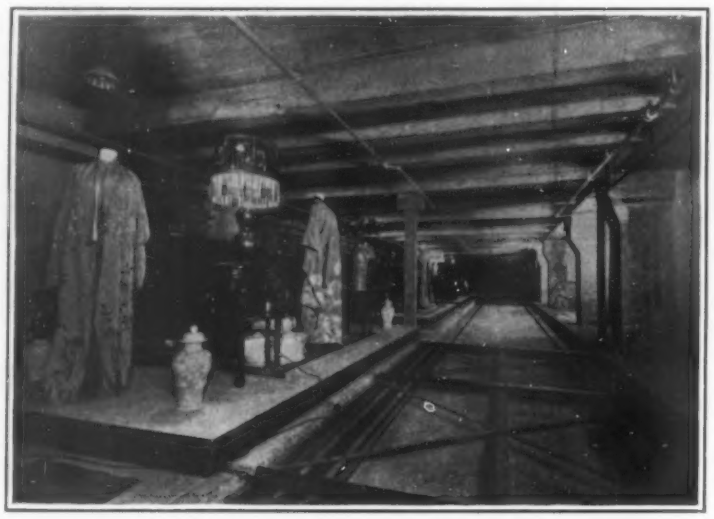
in design...ng this elevating showcase was that of leakage in rainy weather. Special gutters were designed to carry off the water that might leak around the edges of the showcase roof when in lowered position, and also to take care of leakage around the bottom of the showcase when in elevated position. The form of the gutters used is shown in the drawing. Fixed gutters run around the elevator well at the sidewalk level and are arranged to fit under the eaves of the showcase roof when the latter is lowered. At the bottom of the show window are other larger gutters arranged to fit under the fixed gutters when the showcase is raised and trap leakage past the fixed gutters. This system has proved effective in keeping an absolutely dry basement.

Not only is advantage taken of the entrance space, but at each side of the entrance are two narrower show windows with revolving floors or turntables. Each window may be divided by radial panels attached to the turntable, into four compartments, so that four displays may be made in the same window. The mechanism that operates the turntable is arranged to arrest the turning movement as each display comes into view, and hold it there for a minute or so, after which the table turns sufficiently to bring the next display into view.

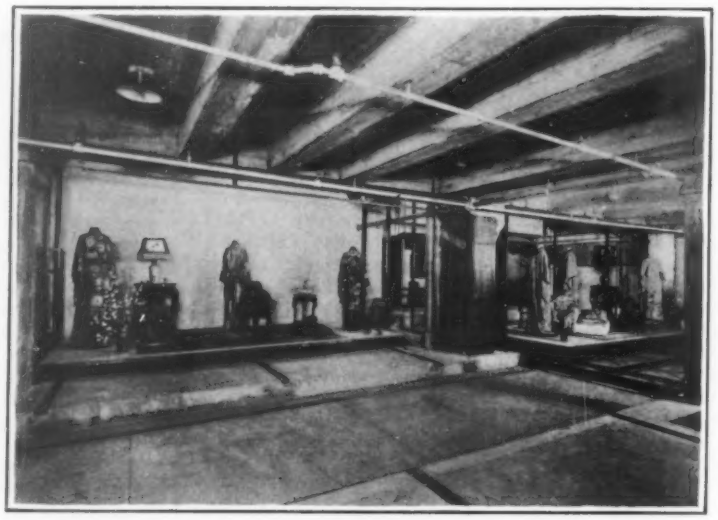
At each side of these revolving cases are two long show windows which, like that of the entrance, are arranged to be lowered into the basement where the window dresser may arrange his display. The window dresser's chamber extends under the sidewalk along the entire front of the store and is well illumined in the daytime by sidewalk lights. Extending down the entire length of this chamber is a trackway on which a bridge or truck may run. Running transversely are trackways adapted to receive window platforms mounted on rollers. The longitudinal trackway is sunk beneath the floor level so that a window platform may be moved out upon the truck, and after being carried down the trackway to any desired window elevator, be moved on to the elevator and raised into the show window. Ample space is provided for a number of these platforms in addition to those on display in the show windows, so that the window dresser may prepare his entire set of displays in the basement in daylight and note their effect. After a complete set of displays has been prepared, the elevators are operated to lower the window displays, which are quickly moved off upon the transfer truck and shunted out of the way, while the new displays take their place. The advantage of this arrangement is that it reduces night work, which has heretofore been unavoidable; practically all the work is done during daylight hours, and only the work of exchanging the new for the old displays need be done at night.

All the elevating show windows use a hydraulic plunger elevator, except the one shown at the extreme right of our drawing. There is a driveway that passes under this portion of the building, making it impossible to use a plunger elevator, and hence an electric elevator is used instead.

Altogether the system is most unique, and is an excellent example of efficiency engineering as applied to store construction. We are indebted to the architects, Messrs. Starrett & Van Vleck, for details of the construction.



The window dressers' room under the sidewalk, showing the transfer system.



Window displays are prepared at leisure and transferred to the show window elevators.

Military Air Scouting by Motion Pictures

By Ernest A. Dench

WHO would have thought that motion pictures could be sufficiently adaptable to prove an efficient aid to army aviators in their scouting work? Yet it is so, thus testifying to the versatility of the film.

Prior to this war experiments had been carried out by Germany, United States, and Great Britain. However, Germany, down to the present time, appears to be the only nation to graduate the idea out of the experimental stage.

Their aviators make it their business to fly over the enemy's location at a great height and to film everything likely to facilitate their attack. The negative is then developed and a positive print printed from the same—the Germans having made special provision for this—and a few hours later the picture is thrown on the screen in the German camp. The commanding officers scrutinize the film with the object of discovering the weak points in the enemy's position, which they lose no time in firing upon. I have it on excellent authority that the motion picture has been directly responsible for a number of the German victories since it has rendered it possible for them to advance in the right direction without the likelihood of the men falling into a trap. Additionally, no appreciable amount of time has been lost in taking the decisive step. The new plan is much safer and more reliable than is spying in the ordinary way.

As to the nature of the special processes by which the pictures are taken, it is a carefully guarded secret. It is stated to be the invention of a German cinematographer who was so patriotic that he disposed of the exclusive rights to the German government about two years ago.

What has stood in the way of movie air scouting being adopted has been the bluriness which mars the films that are produced above while the flying machine is traveling at a rapid pace. Second, the earth has not been sufficiently close for the essential things to be distinguished adequately enough.

In conversation with an English motion picture photographer of high standing, he firmly believes he has succeeded in untying the strings of mystery which surround the German invention.

It is his contention that to control the speed of the swiftly moving aeroplane with the lens of the camera, the inventor has contrived a self-operating camera. The "release" of the film is manipulated by wind while the machine is in motion. When the wind coming in the opposite direction strikes a tiny fan contrivance at the side of the camera, it automatically turns the crank, which then unwinds the film on which everything is recorded in due course. The clockworklike device alone causes the pictures to be photographed at a normal speed.

It also enables the movie-airman to concentrate his energies on controlling the aeroplane, for the only thing he has to do is to release a small lever in order to free the "wind arm."

Apart from this, a powerful lens has evidently been devised, affording a far greater field of vision than is possessed by motion picture cameras already in use. Not only does this permit the operator to soar higher in the air, but makes the pictures seem as though they were filmed just a trifle above ground.

In 1912 Lieut. F. N. Kennedy of the United States Army conducted experiments with the motion picture scouting work. He began the journey from College Park with the assistance of Lieut. Arnold. From an altitude of 1,500 feet he turned the lens toward the road below, shifting it but slightly from one side to the other to cover it properly.

"The one great difficulty," he said, in an interview accorded him at the time, "we encountered—but it is one which can easily be remedied—was in definitely deciding how much territory we were covering."

The British Army Council experimented in rather a unique way. They hired an operator to do some filming from the car of the airship "Beta." The test was this: The Inniskilling Fusiliers had to pretend to be a raiding party. While trespassing in the enemy's territory they endeavored to escape detection from the aerial scouts of the foe. The aviators were aware that their hiding place was somewhere below them and the soldiers could only save themsives by selecting places where the soil or foliage matched their khaki uniform. This was done to determine whether objects are visible against varicolored background.

Steel Darts

THE steel darts used by the French aviators have proved an effective weapon. They are light in weight, running according to size from 45 to 66 per kilogramme (a little over 2 pounds), and owing to their buoyancy are liable to drift with the wind. On this account they are mainly used against extended objects, such as bivouacs in the open, columns on the march, etc. Their effect can always be judged by the commotion caused among the groups of infantry or cavalry, horses especially are terrified by them, and this confusion serves as a guide for the aim of the airman. The reasons given for placing the name of the adjutant aviator Mézergues on the list for the military medal show the prodigality with which they are thrown. The announcement states that in one day this pilot threw 18 bombs and 5,500 darts.

The French journal *l'Aerophile* in a brief account of these darts narrates several stories of their great power of penetration, which it quotes from an article in the German *Medizinische Wochenschrift* by a German physician, Dr. Volkmann. The physician says that a German soldier was killed at once by a dart which struck him on the head. Another soldier was struck on the shoulder by a dart that traversed the chest and was only checked by the hip-bone; the unfortunate man died in a couple of days. Many other soldiers have been literally nailed to the ground by the feet. He calls the dart thrown from aeroplanes a very dangerous weapon, for the wounds produced by these darts nearly always prove mortal. It was a dart shot from a French aeroplane which killed the Bavarian general, von Meyer, as he was stepping into his automobile. The French darts are arranged in groups of 500 in special distributors which the airman works when his sighter shows that he has reached the spot where they should be launched. There are even times when the aviator simply throws the darts by hand in fistfuls. Success depends more on quickness of eye and the training of the airman than on the scientific construction of the sighting device.

An Engineering Foundation

USUALLY any funds given for the advancement of an art or science are put in charge of some institution of learning, but a notable departure from such precedents was made at a combined meeting in New York on the evening of January 29th of the United Engineering Society, representing the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, in combination with the American Society of Civil Engineers, when it was announced that Ambrose Swasey of Cleveland had donated the sum of $200,000 as an initial gift toward a foundation for the advancement of Engineering Arts and Sciences. This foundation is for the promotion of the greatest good of the engineering profession generally and the benefit of mankind. The administration of the fund will be entrusted to a board of eleven trustees.

Mr. Swasey, who has inaugurated this important movement, is of the firm of Warner & Swasey, who built the Lick, Yerkes and many other telescopes, and is himself a well-known engineer and a member of many prominent engineering and scientific societies.

Doing Without Europe—III

How the War Has Affected Our Mineral and Metal Industries and How We May Profit

This is to be regarded as the second installment of the argument which was begun in the last issue of the SCIENTIFIC AMERICAN. *Our object is to show how vast are our own mineral and metal resources and how comparatively little we have done with them. Particularly inspiring is the work done by a paint manufacturer to render himself independent of European barium. Interesting too is the Government's effort to free us from the control of the German potash syndicate.*—EDITORS.

The Slump in Copper.

THE copper industry has probably felt the injurious effects of the European war more seriously than any other of the leading American metal industries. About 50 per cent of our copper has been exported almost entirely to the countries now involved in the European war. While much copper is, of course, consumed in the manufacture of war material, the more constructive arts of peace are far more favorable for the copper industry. We have contented ourselves with exporting the metal in pigs, ingots, bars, plates, sheets, rods, and wire. Europe takes our copper and manufactures it into useful articles worth many times the value of the copper which is bought from us. Obviously, the opportunity for the American manufacturer lies in entering the foreign markets that were supplied by European exports of manufactured goods. European competition is, temporarily at least, destroyed and the low price for the crude material is such that manufacturers would find in copper products a wonderful field for development.

What little arsenic we make ourselves is a by-product from copper and precious metal smelters. We import large quantities from Europe. The American smelters can save much more arsenic than they do now, for the cheapness of the product has prevented the saving of all that was practicable. Although it is difficult for plants exclusively producing arsenic to compete with the by-product of the smelters except in periods of high prices, nevertheless there are two plants in the United States, at Brenton, Virginia, and Mineral, Washington.

The Beginning of a Barium Industry.

Barytes has a wide variety of uses in the manufacture of paint, lithopone, wall-paper, glass, artificial ivory, insecticides, fertilizers, and the like. The largest consumers of barytes are the manufacturers of "ready-mixed" paint and of lithopone. Since the outbreak of the war in Europe many American users of foreign barytes have been forced to look at home for their future supplies.

About two weeks after the European war started, Mr. Maximilian Toch of New York city, a chemist whose life has been spent in improving paints, came to the conclusion that the barium salts which had always been imported from Germany and which were largely used in the rubber, paper, and paint industries of the United States, would have to be made in this country if his firm was to continue in business. His first step was to cast about for a pure barium ore. He found in Tennessee the only ore within shipping distance from the coast, conveniently situated relatively to railroads and waterways. Moreover, the barite ore of other localities contained lime and fluorine, both fatal to the manufacture of certain chemicals. On the 5th of October last, Mr. Toch bought an old plant and began to rebuild it at once. On the 15th of November he turned out his first carload of barium carbonate, barium sulphate, and barium chloride. Since then about fifteen tons of various materials have been manufactured per day, including sodium sulphide crystals and concentrated, precipitated barium sulphate, barium nitrate, and barium carbonate. Although it has been in existence only a few months, the plant has been unable to meet the demand. Its enlargement is a matter of immediate necessity. Thus has the war established the first successful barium industry in the United States.

The question arises how this plant will fare when the war is over and the Germans are once more able to enter our market. Mr. Toch holds that the German ore is no cheaper than ours, nor are German freights lower. German coal is dearer. Germans have been able to make chloride of barium cheaper than Americans because they have native carbonate and by-product hydrochloric acid. On the other hand, we have other advantages. Our sodium sulphide is of a high grade, which enables us to market our other products at a lower rate. With the new German war tax and the high freight rates and the general expensive conditions, Mr. Toch sees no reason to fear German competition.

The Heavy Chemicals.

If so important a mineral as barytes can be utilized, as Mr. Toch has so daringly demonstrated is possible, what may not be expected of a heavy chemical industry?

"The successful introduction into this country of the Solvay process, some years ago, for treating salt, and the later process for the decomposition of salt by electricity has practically driven from the American market the importations of most forms of soda and bleaching powder," says Mr. J. Russell Marble of the J. Russell Marble Company. His statement is significant because the enormous soda plant of the Solvay Brothers in Belgium has been destroyed. France or Germany cannot export soda to this country, and the English plants are running at only one half capacity because their employees have enlisted.

"Our opportunity in this soda field is brilliant. Fortunately for this country," Mr. Marble summarizes the situation, "we have enormous deposits of salt chiefly located in northern New York State, under the city of Detroit and in Kansas and Louisiana, and we have immense water-powers from which electricity can be generated. The manufacture of various forms of soda has been especially successful in this country during the last twenty years, and the effect of the European war, in my judgment, will call for very large shipments of these chemicals to the Mediterranean, Australia, South Africa and South America, and this should lead to the running of the plants in this country to their fullest capacity, so that the immediate effect of the war on the heavy chemical industry will undoubtedly lead to a larger output, to higher prices, and to a more profitable business for the American manufacturer."

Magnesite or carbonate of magnesia finds an extensive use in the manufacture of brick, furnace hearths, crucibles, in the digestion and whitening of wood pulp paper (for which purpose it must be transformed into magnesium sulphite), in the manufacture of crude carbon dioxide, for making oxychloride or Sorel cement, and in the making of refined magnesium salts. We have deposits of magnesite in this country, but they are located in California, far from the eastern markets. It may be that the opening of the Panama Canal will cheapen transportation to such an extent that we may no longer be dependent upon Europe—a suggestion thrown out by a committee appointed by the New York Section of the American Chemical Society to consider the relation of the war to industrial chemistry.

The same committee finds that acetic anhydride can be made without trouble in this country. Ammonia and its salts all depend upon recovery coke ovens, the number of which is increasing as fast as circumstances will permit. Yellow prussiate and sodium cyanide can be and have been made from domestic materials in such an amount as to provide practically the entire home consumption or a great portion of it so long as there was a sufficient duty on them; but the present duty is not enough to protect the American manufacturer and those who engaged in the business soon found it impossible to continue. Hydrosulphites in solution and oxalic acid can be made from domestic materials. Tartaric acid and citric acid can also be made, but radical changes are called for on the part of our grape growers and our lemon growers to meet the requirements of the chemist.

The only mineral substance which has engaged the attention of Congress so far that it has set aside money to study its development scientifically in the United States is potash. Fortunately for us this governmental research was set on foot before the present war. We owe this congressional activity to two circumstances—the controversy started by the German Kali Syndicate a few years ago and the utter dependence of our farmers upon Germany for their potash fertilizers. It was the farmer who roused Congress—the farmer with a vote—not the manufacturer dependent on Europe.

Potash and the War.

The war has served to accentuate this subjugation and to drive home the absolute necessity of rendering us independent of the great Stassfurt potash deposits. All the industries dependent upon potash have been affected. Lower grades of potash which would ordinarily find their use in fertilizers are bought up by glass makers and potters. Some manufacturers have even substituted soda for potash in glass-making.

Few of us realize how all-important is potash, not only in agriculture, but in industry. It is the chief ingredient of many fertilizers. Its salts are used in the manufacture of glass, explosive powders, certain kinds of soap, and in mechanical industries, including the manufacture of alum, cyanides, bleaching powders, dyestuffs, and other chemicals, among which are arsenite of potassium, bromide of potassium, chlorite of potassium, permanganate and manganate of potassium, nitrate of potassium, silicate of potassium, etc. The chemical manufactures alone dependent upon German potash salts are of enormous magnitude. Potash alum is extensively used in the dyeing industry and by paper makers and leather dressers.

Can we become independent of Germany for potash? The annual imports of potash salts during the past three years have averaged about 635,000,000 pounds in quantity, and $11,000,000 in value. These figures, however, represent only a part of the potash salts entering the United States, as they do not include the imports of fertilizers. The quantity of materials of this class imported for consumption during the last three years has averaged about seven hundred thousand tons, valued at $4,300,000 annually. Thus, it is apparent that the value of the annual imports of potash salts exceeds $15,000,000.

Our Own Potash Supply.

There is a natural deposit at Searles Lake, California, of some 4,000,000 tons, equivalent to a few years' supply for fertilizer alone. The Government performed a valuable service not only in calling attention to Searles Lake, but in scientifically studying the region at great expense for industrial development. Partly as the result of this governmental interest an experimental plant has been built at Searles Lake. Its success or failure will be watched with interest. The Government has found that in Oklahoma there is a possible source of sulphate of potash; and that in Texas there is potash about 2,200 feet below the surface. Alunite, yielding after treatment about 18 per cent potash sulphate, is deposited in Utah, Colorado, Nevada, and Arizona.

But the great source of potash is the felspar and granite rocks of New England. Many of them contain from 8 to 12 per cent of potash. As yet no commercial process has been perfected for rendering this potash quickly available to plants. Mr. W. H. Bowker, whose connection with the American Agricultural Chemical Company enables him to speak with authority, says:

"There is a great fortune awaiting the man who can invent a feasible and cheap process, but the potash must be soluble in water, and it should be produced at a cost not exceeding $20 a ton (on the basis of muriate) laid down in the Eastern markets, for if put to it, the Germans could sell their potash at that price in this market and even for less."

The Powerful German Potash Syndicate.

This leads one to inquire into the German situation. The Stassfurt mines can raise and refine the mineral for $8 a ton. The price in cargo lots varies from $35 to $34 a ton, delivered at seaboard. The German Kali Syndicate sees to it that a handsome profit is maintained by limiting the production of the mines and by fixing the price arbitrarily. Prof. H. A. Huston, who is said to take care of the Kali propaganda in our Eastern and Southern States, has been quoted as saying:

"We have one hundred and ninety mines, forty of which would supply the world very nicely. We are prepared for almost any sort of emergency demand."

If the situation is thus correctly pictured, if Germany can release large quantities of potash when the war is over, simply by raising the embargo on production placed on the mines by the Kali Syndicate, aided by the Reichstag, what are the chances for an American potash industry?

The question is so important, both to agriculture and industry, that the United States Geological Survey has endeavored to locate deposits in this country and has followed up every clue that seemed to promise results of importance. And the Bureau of Soils of the Department of Agriculture has investigated the kelps.

Kelp as a Source of Potash.

Probably the leading authority on the possibilities of kelp in this country is Mr. Frank K. Cameron of the United States Department of Agriculture. "The dried kelp," he tells us, "contains from 20 to 35 per cent, or occasionally even more, of potassium chloride, and is more desirable than manure salts or ordinary market grades of potash salts, not only because of its high content of potash, but because of the readily decomposable organic matter, a content of about 2.5 per cent nitrogen, and appreciable amounts of readily soluble phosphates, all of which give it an important fertilizer value.

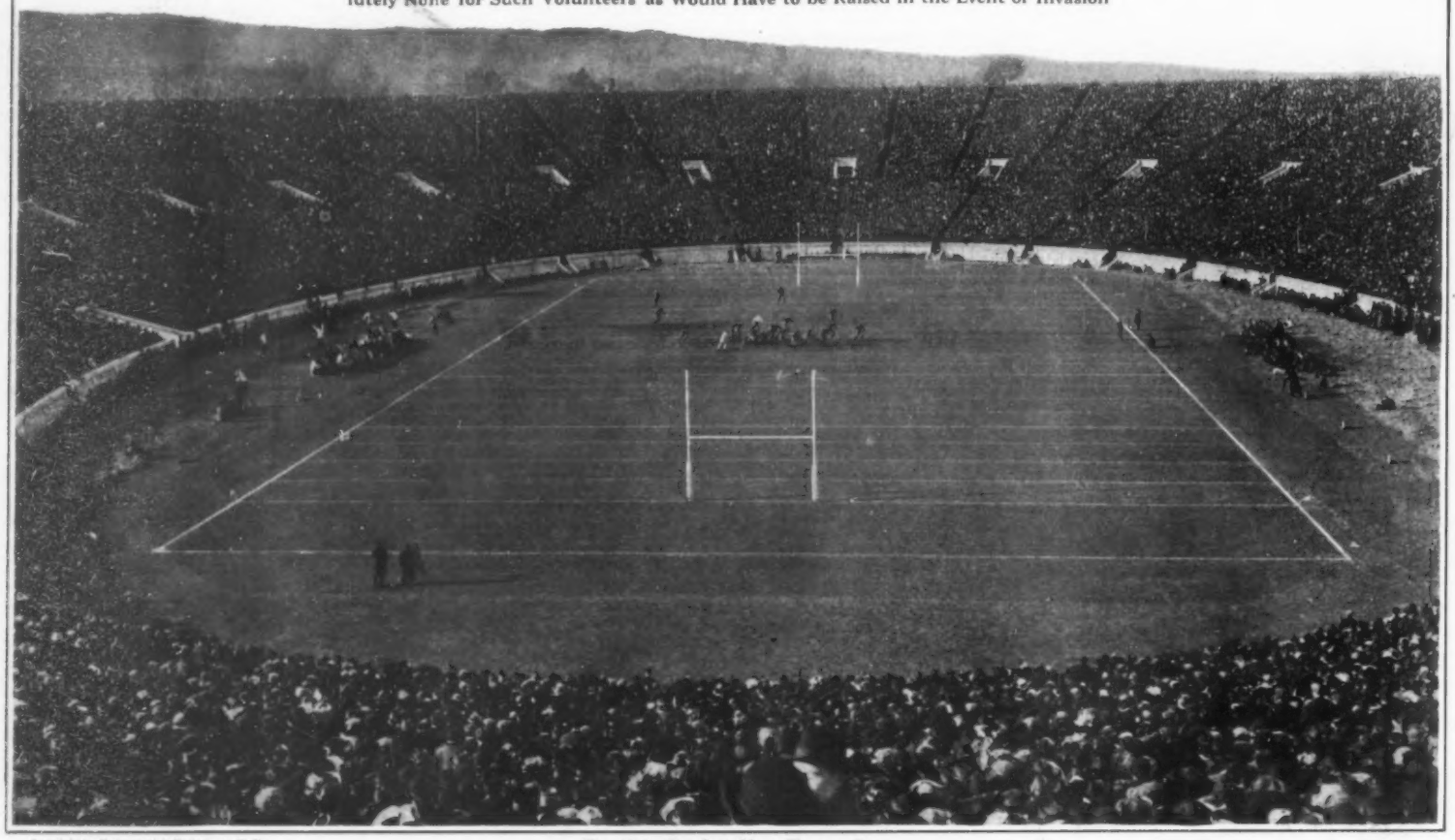
"The recovery of high-grade potassium chloride from the kelp is no more difficult than from the Stassfurt salts. The recovery of iodine and organic products, leaving a residual rich in potash, is quite feasible, but has not yet been attempted in this country, except on a laboratory scale, although now practised in Japan.

"The amount of potash salts obtainable annually from kelp cannot be stated at all satisfactorily at present. It is certainly large, and if careful supervision of the beds and harvesting be provided, it seems safe to as-

(Concluded on page 164.)

II—The United States an Undefended Treasure Land

We Are Short of Arms and Ammunition for Regulars and Militia, and Have Absolutely None for Such Volunteers as Would Have to be Raised in the Event of Invasion



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The Yale Bowl at New Haven, Conn.

If the whole 90,000 effectives of the regulars and militia could be placed within the Yale Bowl, there would still be room for a game of football.

[*The second chapter of the series on the defenselessness of the United States shows our deplorable lack of the field guns, rifles, ammunition, uniforms, tents, transportation equipment and various supplies, without which Secretary Bryan's army of "a million volunteers" would be a mere mob of no military value whatsoever.*

From President Washington to President Wilson, the Executive has persistently urged upon Congress the necessity of providing, in times of peace, a body of citizen soldiery properly trained and equipped, with which instantly to meet and repel any invasion of the United States. With equal persistency, Congress (except during periods of war) has refused to listen to the warnings of its Presidents. To-day, thanks to this neglect, the United States, the richest of the rich countries of the world, is the most open to invasion. The ocean, once a barrier, now, thanks to steam navigation, offers a choice of half-a-hundred highways, by way of any one of which a first-class power, in the event of the defeat of our fleet, might, within a week or ten days, land a fully equipped advance force of 200,000 highly-trained troops. To oppose this, the United States, in thirty days, could concentrate, at the most, 30,000 regulars and 60,000 militia.

The present series of articles is published with a view to bringing before the country at large and Congress in particular the true facts as regards the military defenselessness of the United States. They represent the result of weeks of study of the problem by the editorial staff of the SCIENTIFIC AMERICAN, *in the course of which only the highest military officials and the latest official documents of the War Department have been consulted. What is Congress going to do about it?*—EDITOR.]

WE have shown in the previous chapter that, in order successfully to meet an invasion, the United States require, in the early stages of the war, a mobile force (regulars, militia, and their reserves) of 500,000 men; whereas, as a matter of fact, we possess only 90,000 such troops to-day.

We now direct attention to the fact that we are without adequate artillery guns or ammunition for this combined regular and militia force, and it will be years, at the present rate of progress, before we accumulate the guns and ammunition necessary for this combined force at war strength. The estimate on which the Department has been working is for 1,292 guns, and 634 of these guns are actually completed; also 226 others are under contract. Of field artillery ammunition, there is only a small percentage of the total amount required.

Lack of Field Artillery Guns and Ammunition.

We have in the hands of troops, or stored, 634 completed guns. We have under manufacture or contract, 226. These guns will probably not be completed for at least a year and a half. In other words, the number of completed guns is a little less than half the total number deemed necessary for the field force of 500,000 men, and provides no guns whatever for the coastguard troops or new volunteer organizations which will be required in addition to the 500,000 field force. Of ammunition, we have, made and under contract, approximately 30 per cent for the entire project of guns (1,292). Half of this is under manufacture or contract, so that there is not more than 15 per cent actually completed. For the guns on hand and under manufacture we have, of ammunition on hand and under manufacture, about 41 per cent; actually on hand, approximately, 20.5 per cent. For the guns actually made (634) we have 27 per cent of the ammunition necessary. For the guns now in the hands of the regular army and militia we have about 44 per cent of the ammunition necessary. It should be remembered, however, that the guns in the hands of the regular army and militia at the present time are less than half the guns required for these forces when properly equipped with guns, even under our scheme for the assignment of guns and ammunition; which is in both instances far lower than in any of the great armies to-day, and the present war has indicated, in the case of one great power at least, that the consumption of ammunition has exceeded twice their maximum estimates, and that the proportion of artillery will, in future, be increased.

At the rate of even last year's appropriations, which were the largest made for field artillery guns and ammunition, it will take between eight and nine years to complete our present modest estimate for guns and ammunition, and the necessary equipment in the way of ammunition trains and other accessories.

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These men are recruits, not soldiers.

It takes at least six months to make the one into the other.

We Have Absolutely No Artillery for the Needed Volunteer Coastguard Force of 380,000 Volunteers or the Vast Volunteer *Mobile* Forces that Would Have to Be Raised Back of Our Front Line.

This total number of guns, 1,292, represents practically only enough guns for the field force of 500,000 men made up of the regular army and the militia brought to war strength and with necessary new organizations. It does not provide a single modern type field gun for the coastguard force or one for the great force of volunteers which will have to be promptly raised in time of war. These forces will be helpless against a well equipped enemy with artillery, and it can be assumed as certain that any attacking force will be fully equipped in all particulars. Is this haphazard policy either just or fair to our volunteers? Are they not entitled to such equipment as will give them a fighting chance? No adequate steps are being taken to provide it. The present entire gun-building resources of the United States, working day and night, could not make good our deficiencies in guns or ammunition within one and a half years; that is to say, within a period which would exceed that of

Photo. by Underwood & Underwood

Troops entraining baggage wagons at Galveston.

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American outpost entrenched at Vera Cruz.

most modern wars and within the period which would in all probability determine the issue. These are plain and disagreeable facts. They cannot be controverted, and what is worse, there seems little inclination outside the army to make any effort to improve these conditions.

During the First Few Months of a War of Defense Against a First-class Power We Would Require in Regular and Militia Field Forces, Coast Artillery, Coastguard Force, Volunteers, Etc., About 1,000,000 Men.

The figures as to men required, for the field force and coast guard, represent in round numbers, including the coast artillery and its reserves, about 800,000 of men. regular, militia and volunteers, as the force which will be needed at the commencement and during the first few months of war—a million will be more nearly correct when all the demands of the situation are considered. When it is remembered that during the Civil War, when our population was about one third of what it is at present, we had, North and South, nearly 4,000,000 different men under arms and that we had about 1,200,000 North and South under arms at the end of the war, these figures do not seem to be unduly large. This statement shows what we have immediately available (90,000 mobile troops and about half the coast artillery required) and what we shall need in order that we may be reasonably well prepared to meet successfully the first shock of war with a first-class power, and it is only for preparation for conflict with such a power that we need particularly to concern ourselves. The little wars with little nations, we can take our own time to prepare for. In fact, our peace force, if we provide the necessary organizations to complete three tactical infantry divisions with their necessary artillery, three cavalry brigades, the necessary auxiliary troops, etc., within the continental limits of the United States, will generally be sufficient to furnish an expeditionary force for minor operations. The big wars with the fully equipped, strong nations, are the wars which threaten us and the ones for which we have made no preparation, worthy of the name.

The Army Staff Asks for a Small Standing Army With a Large Trained Reserve of Regulars, Militia and Volunteers With Their Officers Back of It.

The policy of the Army General Staff has not been for a large standing army, but for a standing army adequate for the police work of the day, i. e., an adequate garrison for the Philippines (20,000 men), a garrison for the Hawaiian Islands (16,000 men), for the Panama Canal (9,000 men), a small force for Porto Rico and Alaska, amounting to a regiment each, and the remainder within the limits of the continental United States. It has recommended that the regular army in the United States be increased, so as to provide three tactical infantry divisions in the continental United States, three cavalry brigades, and a division of army troops and a coast artillery force of approximately 19,000 men in time of peace. It has advocated a form of enlistment, under which men could be transferred to the reserve as soon as they were sufficiently trained and their places taken by others. Its recommendations have not been heeded by Congress, and upon the completion of our foreign garrisons, the regular forces in the United States will be sixteen regiments of infantry, with about 840 men per regiment, and eleven and two thirds regiments of cavalry, with about the same strength per regiment; three regiments of field artillery, with twenty-four guns per regiment, and certain auxiliary troops. Is this an adequate force for a population of nearly one hundred millions of people?

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American field gun in position.

Our Present Effective Field Army (Regulars and Militia) Could Be Put into the Yale Bowl and Leave Room for a Game of Football.

The mobile troops in the United States, amounting to about three times the police force of the city of New York, taken with the *personnel* of that portion of the militia which is efficient and ready for service, can all be put into the Yale Bowl and room still be left for a game of football. Think of it! The total available mobile troops is less than one third the number estimated as needed for an adequate coast guard alone and only about one sixth of that needed for the field force, and no steps have been taken or are being taken to correct this alarming condition. No one who is familiar with the subject expects the country to maintain a force of the strength of that which would be needed in war on a war footing in time of peace; but they realize fully the necessity for making in the greatest detail all arrangements for preparing promptly the forces which will be needed in case of war, and especially do they realize the absolute necessity of having the regular army and the militia so maintained, both as to reserves and equipment, that they can be immediately brought to full strength, fully armed and equipped, and with reasonable reserve supplies. The necessity is also appreciated for completing, in advance, all arrangements for coastguard troops, because, as stated above, it will be destructive to the usefulness of the field force to attempt to take from it coastguard troops. Moreover, the demand for the coastguards will be such as to make it impossible to supply them from the regulars and militia, without entirely using up the available force of these troops.

The Shortage in Small Arms.

The reserve in the case of small arms is better than in any other detail of equipment, excepting small arms ammunition; but even in the case of small arms (service rifle) the amount available, 698,000, including guns made and under manufacture, is insufficient in view of the number of men which will be required for the field force, coastguard, and additions to the field force in the shape of volunteer organizations in the early stages of war. This force will undoubtedly steadily increase, and will increase at a pace which will be far beyond the capacity of the arms factories to meet. The wastage in small arms is always heavy. Many are broken, many are shot to pieces in action, many are lost through capture; they are bent, injured, and put out of commission in various ways. The reserve of small arms should be liberal—not less than a million and a quarter. The present policy of establishing a reserve of a million is barely sufficient to meet the demands of the first few months; and right here it may be well to point out the inadvisability of the Government attempting to manufacture exclusively its own military

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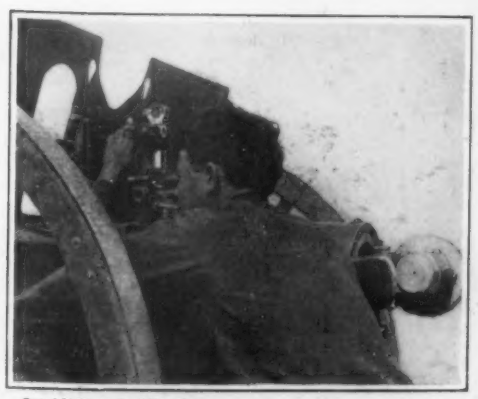

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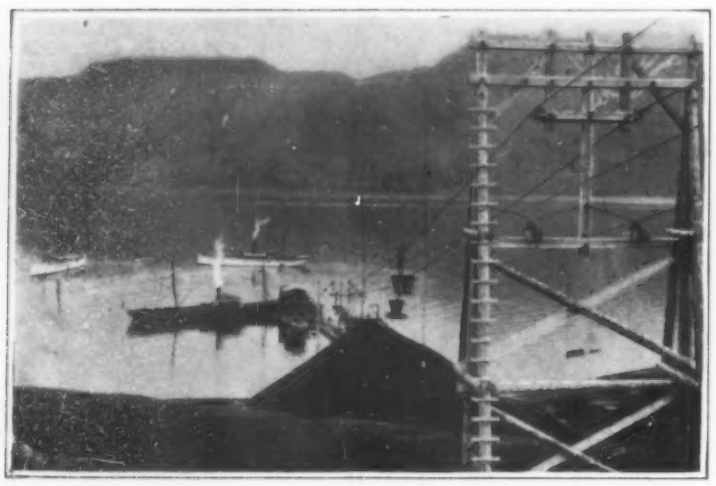
Artilleryman using periscopic sight on field gun.

Photo. by Levick

Scene at headquarters during volunteer militia maneuvers.



Steamer taking coal and two others waiting their turn.

The upper loading station.

Heat from Our Lady of the Snow

Coal-Mining in the Arctic Circle

By H. J. Shepstone

THE successful mining of coal in Spitzbergen, and the erection there of an ingenious cableway for transporting it to ships, calls attention to the development of this strange archipelago in the Arctic circle. It is just over a year ago that this famous group of islands, lying some 400 miles north of Norway, was declared neutral territory. This was the result of a conference between the governments of Russia, Sweden, and Norway to settle the question which was frequently asked as to who really owned Spitzbergen. The country is now open to all nations and is governed by a joint board consisting of one representative of each of the three powers named. It had long been known, of course, that coal existed in Spitzbergen, just as it does in Greenland and Alaska. It was generally believed, however, that it was too poor and the seams insufficiently thick to prove of any commercial value.

So far as Spitzbergen is concerned, opinions on the value of the coal lying there have greatly changed. In the summer of 1911 some twenty-five large cargoes of coal were mined and exported, the output in the following year being increased to over one hundred cargoes, while to-day between 500 and 600 shiploads of coal are carried away from its inhospitable shores during the summer months.

The coal found in Spitzbergen is of good quality. It contains only 2 per cent of red ash, no slag at all, and is free from slate. The prices obtainable are good, and amount to $4 per ton in Advent Bay for direct sale to the whalers; $5 at Trondhjem, Norway; while English coal on the north coast—in Hammerfest, for example, the most northerly town in Europe—costs about $7.50 per ton.

The coal often comes to the surface, and is worked by a Boston company, which has secured in Advent Bay a coal-field three to four miles long. The company has undertaken further expeditions with its steamers, and has also found a coal-bed in Saxon Bay at a height of 400 feet above sea level, which, however, is not sufficiently productive to pay for its working. At Cape Bojan very good coal is also to be found, though here, on account of the heavy surf, the working is fraught with considerable difficulties. On the other hand, the company has taken over a coal mine in the vicinity of the fish-oil boiling house in Green Harbor, 200 feet above sea level, which yields a very good and firm coal, and here there are good landing facilities.

The working of the coal, which, up to the present, has been carried on only in Advent Bay, is advanced by gallery-driving. The galleries are driven almost horizontally into the mountains, the coal being cut, and only props left as supports. Walling is not necessary, as a temperature of 42 deg. Fahr. prevails in the galleries, so that the mountain remains quite firm. The working of the mine is, according to the time of the year, divided up into two parts—the summer and the winter campaigns. For the summer campaign, which lasts from the beginning of June till the middle of September, 200 men come from Norway to Advent Bay by the company's steamer "Munroe." During the winter only 100 men remain there. They work 9¾ hours a day and live, from eight to twenty men, in workmen's houses, which consist of board partitions fourfold thick with cardboard between.

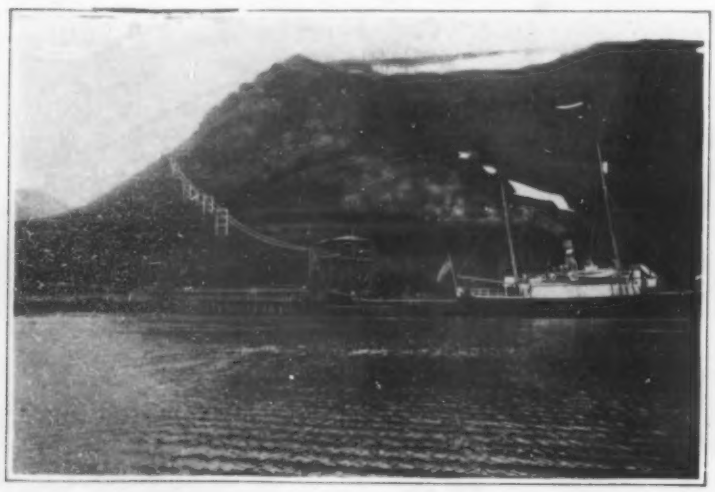
The coal is carried from the galleries at a height of about 650 feet above the level of the sea, and immediately tipped, near to the gallery mouth, over a chute into a hopper which extends close up to the coaling station of the ropeway. The wire ropeway then carries the coal direct into the ships. The ropeway possesses a rather heavy gradient from the loading station, located on the mountain above, to the unloading station erected in the sea. Its horizontal station consists of a hopper building and a suspension railway circuit on which the ropeway cars are loaded. They are then pushed out of the station by hand and couple themselves automatically to the traction rope, which is in constant motion. The ropeway runs over sixteen wooden supports and has a free span of 800 feet from the last support to the unloading station in the sea. The depth of water in front of the unloading station is 36 feet, so that large ocean steamers are enabled to come alongside.

Special difficulties hindered the erection of the ropeway, as all building material, including logs from 55 to 65 feet long, had to be brought in by ship. The driving sheaves, and the break regulator weighing about two tons, had to be lifted by means of winches and steel ropes, the boulders on the mountainside, which were continually crumbling away, presenting very considerable difficulties. The piling of the supports and the laying of the foundations of the structural parts were much impeded by the permanently frozen ground. Only under the direct rays of the sun does the ground thaw, and then only to a depth of 8 inches. All holes, therefore, had to be blasted with dynamite. The pile-driver was then set on the ice and the supports driven into the holes. At the commencement of the erection work the company's steamer was not successful in getting into Advent Bay, because Spitzbergen was surrounded by pack-ice. It was, therefore, necessary to drag all the building material over the ice on sledges.

Spitzbergen has now undertaken the supplying of coal to whalers cruising in the polar sea and to the north of Norway, thus competing with the English coal previously unchallenged there. This state of affairs has been thoroughly grasped, and an English company has taken in hand the mining of a Spitzbergen coal-bed.

The Current Supplement

THE current SUPPLEMENT of the SCIENTIFIC AMERICAN, No. 2041, for February 13th, is unusually varied in contents and interest. Meroë, the Royal City of Ethiopia, tells of discoveries that throw light on astronomy as practised centuries ago. Waste in Hiring and Discharging Employees raises and discusses an economic question of the greatest importance to every employer of men and to every student of economic subjects. Making Safe Steel Rails describes a radical method of treating material to eliminate certain causes of frequent failures in railway rails. New Faunal Conditions in the Canal Zone gives some details of an expedition that investigated the results of the creation of the Gatun Lake. Other articles treat of protection of ships against torpedoes; a review of developments in wireless telegraphy; the inventions of Edward Weston; Twilight Sleep; a war-time fertilizer; the Treatment of Blast Furnace Gas is continued, and there are other matters of value to all who like to keep themselves informed on the doings of the scientific world.



The aerial cableway as viewed from the water.

The cableway running inland.

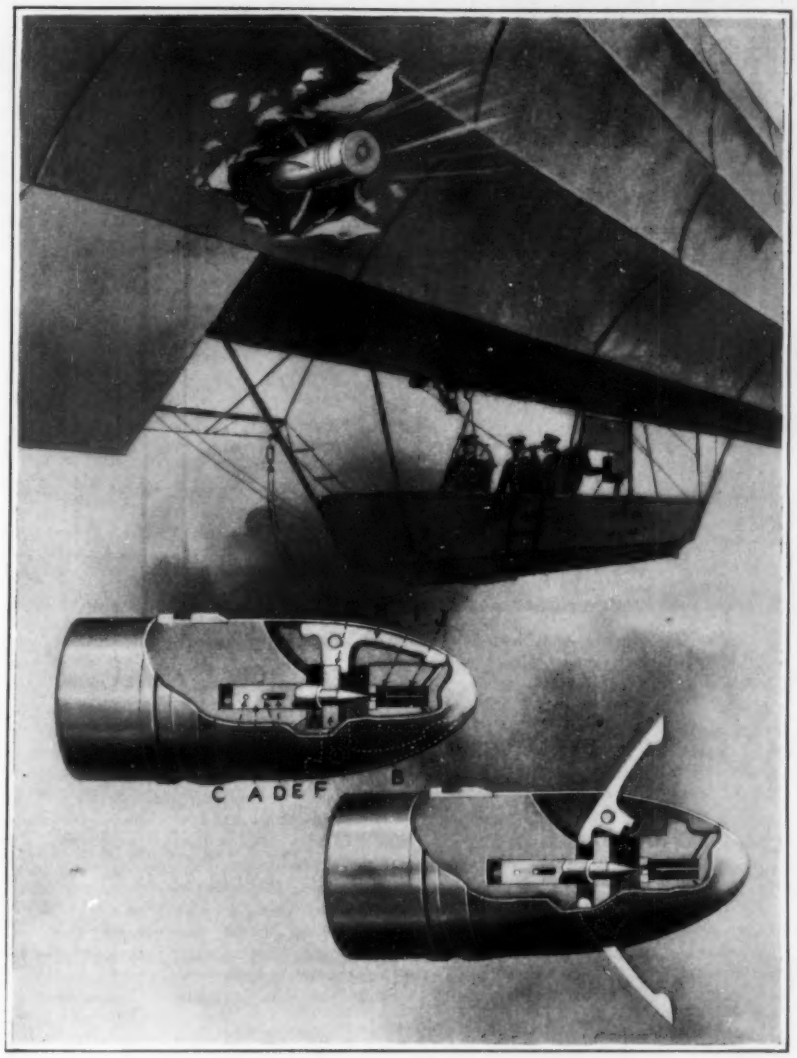
Inventions New and Interesting

Simple Patent Law : Patent Office News: Notes on Trademarks

Shells for Destroying Airships

THE recent raids on the English and French coast towns by the Zeppelin airships have given fresh point to the discussions of methods of defense against aerial cruisers of this sort, and how they can best be destroyed. It is evident to all who have considered the subject with a knowledge of the construction and character of these craft that a shot, even of large size, penetrating the huge gas reservoirs is not likely to have any serious effect, for the gas would be liberated so slowly from any ordinary sized hole that the vessel might not be seriously inconvenienced, and even if eventually compelled to land on account of the injury, might easily keep the air until it reached friendly territory. To be effective, therefore, a projectile to be used against airships must be capable of producing an opening in the envelop of very considerable size.

It is interesting in this connection to note that the subject has not been overlooked by those who make a study of military subjects, as is indicated by a patent for a special projectile that was issued recently to the firm of Sir W. G. Armstrong, Whitworth & Co., the great builders of warships and guns. The invention is illustrated in the accompanying drawings. It will be seen that this projectile carries in longitudinal slots cut in its head a series of pivoted blades *H*, which ordinarily are held in place within the shell by a disk *F* on the firing pin *A*, which engages a notch *G* in an arm of each blade. The firing pin *A* is normally held in place by a light shearing wire *C*; but when the projectile is fired from a gun the shock of the discharge, acting through the inertia of the firing pin *A*, causes the pin to be thrown backward, shearing the wire *C*, and releasing the blades *H*, which then open out as the result of air pressure or centrifugal force, and the projectile in this condition is capable of tearing an opening in the envelop of the airship several times the diameter of the shot itself, and the whirling motion of the projectile is expected to add to this result. But mere penetration of the envelop of the gas compartment is not the only result expected of this new projectile, for it is constructed as an explosive shell containing a charge of high explosive, as shown at *J*. After the firing pin *A* has severed the restraining wire *C*, its movement is still limited by a second shearing wire *E*, that passes through a slot *D* in the pin, and no ordinary movement of the shell will result in its discharge When, however, the extended blades *H* strike anything that causes resistance they are forced backward, and their extended rear ends acting on the disk *F* will force the firing pin *A* forward, shearing the second restraining wire *E*, and driving the needle point *B* into contact with the detonator *I*, which explodes the shell. It will be seen that this explosion is calculated to take place within the body of the airship, with the result of disrupting the gas containers, and probably firing the gas as well, thus effectively destroying the craft, or at least compelling instant descent. Whether these shells have been brought into service or not has not been announced.

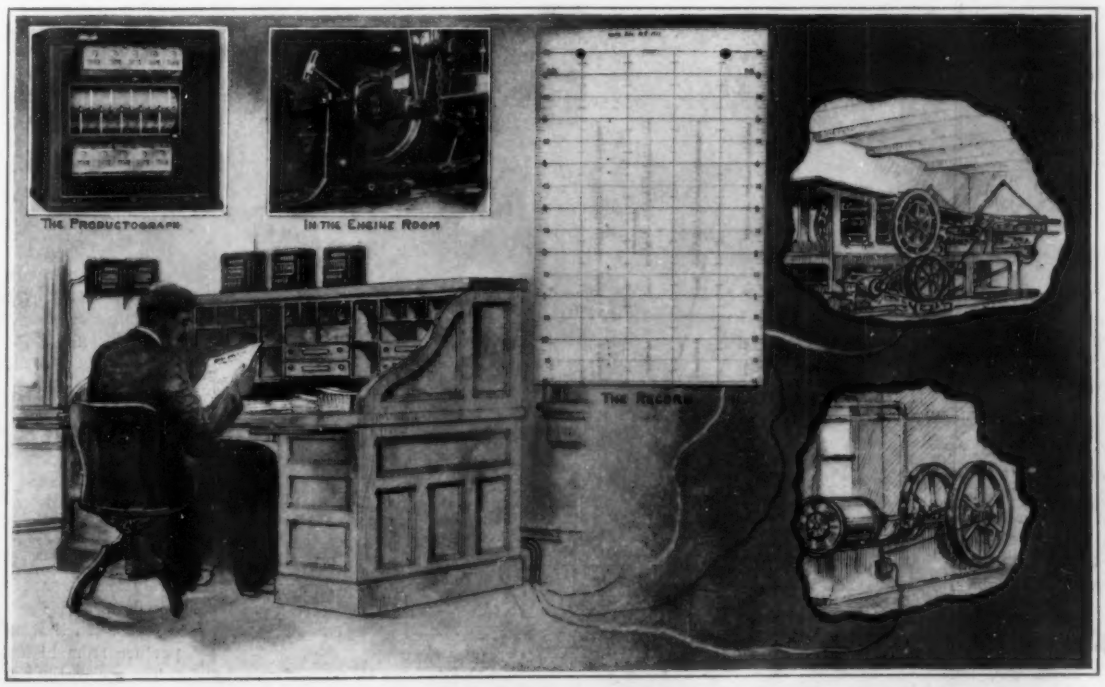


A new explosive projectile that tears open the gas bag of an airship.

Watching Distant Machines from a Desk

By Herbert T. Wade

IN manufacturing and all other mechanical operations where an effort is made to secure increased efficiency, or the maximum results from a given plant or equipment, with a fixed or minimum expenditure of energy, power or personal attention, it is naturally of fundamental importance to secure an accurate knowledge of the performance of a given machine or individual. In short, efficiency studies may be divided roughly into those where the personal side, dealing with the laborer or operative, is paramount, and those where the output and performance of a given machine are investigated. Efficiency, in other words, is simply a ratio, and the higher the percentage of actual output or performance, as compared with possible performance or output, the greater the return to the wage payer or owner. The mechanical problem involved in studying the performance of a machine in its essence is of the simplest; a shaft makes so many revolutions, so many yards of cloth are woven by a loom, so many barrels of flour are packed at a roller mill, so much current passes through a recording wattmeter, an elevator travels so many miles on its daily travels, and a thousand and one other operations. All these items must be considered in relation to some unit of time as a rate of production or measure of efficiency, and must be indicated plainly to be digested by a responsible head of the plant. If one of ten machines is idle, the output is correspondingly decreased by 10 per cent for the length of time it is inoperative. If fewer yards of cloth are being wound off the loom than its rated production, there is a corresponding loss to the mill. Accordingly, any device that assembles for the information of a central head an actual record of the performance of his machinery is invaluable, not only as an indication of what is happening at the instant, but as supplying a basis of comparative cost accounting. The efficiency studies should not stop at mere indication, study, or suggestion, but be so presented as actually to secure increased efficiency, either by indicating at once the necessary repair or adjustment of machines, the addition of new and superior equipment, or the elimination of lost motion at one point or another along the line. To secure this elementary datum, and place it at the disposal of a cen-



Productographs in the manager's office that record the exact amount of work done by the different machines throughout the factory.

tral head, there has been evolved recently an instrument known as the productograph, which in connection with modern methods of economy and efficiency studies brings to a common center and there records the necessary data as to the mechanical operation of a plant, whether the various elements or machines of the same are separated by considerable distance or not. The productograph consists essentially of a special form of switch by which an electric current is opened and closed, corresponding with the operation of a machine or mechanism. Such a device in essence might be of the simplest character, but in this new system the switch is arranged so that for every motion to and fro of its lever a ratchet is advanced by one tooth, while a second wheel carrying a cam mounted on the same axle does not operate a lever connected with a dash pot and electric circuit breaking mechanism, until the first wheel has been advanced by ten teeth, corresponding of course to ten movements; then a circuit is completed and the current, which is supplied at low voltage from a special motor generator set, is sent over a conductor to the indicating mechanism. The pneumatic cylinder of the switch prevents absolutely any short circuit. The indicating mechanism consists of a series of electromagnets, one magnet for each circuit, each, however, supplied with two armatures, one of which actuates an indicator having numbers on the faces of its dials or revolving wheels by which the number of revolutions or other movements of the switch are shown, while the other armature and mechanism is connected with a German silver pin or needle point, which on the closing of the circuit makes a line on a strip of lead paper driven by clockwork, so that a graphic record appears in the spaces divided to represent hours and minutes. The mechanism is so arranged that each tenth stroke is longer through the increased motion of the armature, and as each stroke corresponds with ten movements of the original switch, the long marks on the record indicate 100 movements of the machine.

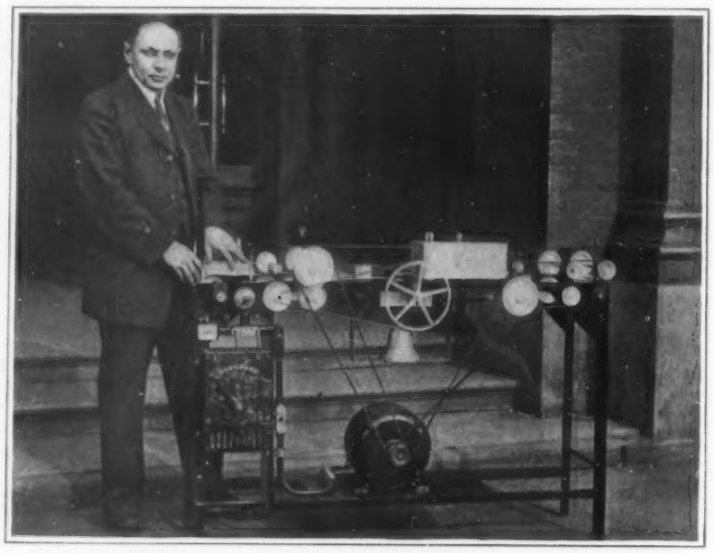
As actually installed in many plants a number of these recording devices are combined; as many as twenty have been arranged together, and while they are all similar in their general action, yet the information that they supply may cover a wide range of activities. Thus in a large printing plant one switch may be attached to a linotype machine and the number of lines set by the operator be registered automatically on the dial. Another machine may be connected to a press and give the number of sheets printed, while another in the bindery may indicate the number of books bound. Yet before the manager's eye the complete activity of the plant is apparent.

Again in other establishments the number of bottles filled, the number of defective bottles, the number of cases, the amount of liquid passing into a tank; the amount of coal weighed into the coal elevator, the number of movements of a dredge bucket; and, in fact, all desired information immediately and quantitatively is recorded.

In all efficiency studies knowledge of conditions and performance is the first consideration, and with this accumulated by a device which indicates also the production, the efficiency engineer or superintendent can proceed to better his output.

Realizing as he can at a glance, that machine No. 10 was idle for two hours, it is possible to investigate the reason and to provide against such shortcomings in the future, whether they are the result of personal or mechanical causes. If another machine supplies but a fraction of the output of its neighbor it does not take very long for the efficiency engineer to determine the fact and to change conditions.

The records are available for analysis either by the managers of the plant or by trained outside experts, and the logical development would seem to be a central office of efficiency where a superintendent would analyze not once a year, but once an hour or at even a less interval what is happening within the walls of his factory, or, in fact, within several allied establishments. So far the system has been made with twenty indicators, but there seems to be no limit as to its application either in extent or in range. The current, which amounts to but one half ampere per needle, may be derived from any lighting circuit, either alternating or direct, preferably through a motor-generator, and the low voltage of the operating circuit does not present any difficulty in the way of wiring to increase the insurance hazard or to involve undue expense either for installation or maintenance. While all efficiency studies and work are fundamentally psychological, yet mechanical adjuncts play an important part, and of these the productograph is typical of what may be used in order to secure and properly co-ordinate the knowledge on which mechanical efficiency must depend.



Machine that seals one thousand envelops per minute.

The Envelop Sealer of the Pension Office

As may well be imagined, the envelop output of the Disbursement Office of the United States Pension Office, at Washington, D. C., is very large indeed, and there has been a demand for a machine of large capacity for sealing envelops. Realizing this need an assistant messenger of the office, Mr. Fred W. Carrington, undertook to build a machine of the type required. In this he was successful. The capacity of the machine so far as has been tested is from seven hundred to a thousand or more envelops per minute.

The envelops can be placed in a bunch or bundle upon the feed belt, and will automatically feed themselves into the machine and pass out at the delivery end properly sealed.

At present the receptacle for the sealed and delivered envelops is not in the most satisfactory form, and will constitute the subject of another invention. A patent on this machine was granted to Mr. Carrington on December 15th, 1914 (No. 1,120,688), and he has dedicated it to the public. As a reward for his ingenuity and service to the Government, President Wilson has appointed Mr. Carrington to the clerical grade without examination under the Civil Service Bureau. The features of Mr. Carrington's machine, which are regarded as of considerable importance, are the means of adapting it for envelops of different sizes, and particularly a feed belt of corrugated rubber, which is laid off in sections, the belt being operated rapidly to feed the envelops one at a time into the machine. The moistening means includes a pan of water heated by an alcohol lamp, it having been found that the machine operates so rapidly that cold water will not soften the glue of the envelops in the short space of time in which the envelop passes through the machine.

Nikola Tesla's Fountain

It is a curious fact that, old as fountains are, they have remained essentially unchanged in principle for centuries. Artists have lavished all their skill upon them to make them beautiful, but engineers have neglected them. To be sure independent pumps of small volumetric capacity have been used to create artificial waterfalls and to use the same water over and over again. But this principle is old and the spectacle offered to the eye not a great improvement over the fountains of olden times.

Two types of fountain have chiefly prevailed—the cascade in which a moderate volume of water falls in thin but brilliant sheets over multiplied obstructions—steps, basins, rocks, etc.—always in a framework of architecture with abundant obstructive accessories; and the isolated or central fountain, in which one or many jets, spouted upward, fall into the highest of a series of superposed bowls of marble or bronze and then into a larger one below and so on into a broad basin at the ground level. Although every effort was made to save water and to obtain the maximum effect, still we find that in most European cities, fountains are allowed to play only on certain days of the week, and then only for a few hours. It may be safely said that not since the days of the Italian Renaissance has any really startling improvement been made in the hydraulics of fountains.

Into this neglected field, Mr. Nikola Tesla, the distinguished engineer, has entered, and as might be expected of him, with very strikng results. He has recently patented a fountain of entirely new principle, and one moreover in which imposing effects are obtained with very simple apparatus and with a very small volume of water. The accompanying illustration pictures the very simplest form of fountain which can be constructed, according to Mr. Tesla's ideas. A shaft runs vertically through the central column of the fountain, carrying at its lower end a propeller, and at its upper end an electric motor, suitably braced. In our illustration we show this propeller shaft contained in a tube, the bottom of which is provided with inlets for the water in the main bowl. As the propeller is made to revolve the water is sucked in by the propeller blades through the inlets, and is urged upward in the direction of the arrows. It fills the upper bowl and then overflows in a miniature waterflow of impressive size.

Nikola Tesla's fountain, in which remarkable results are obtained with little water.

As the circulation is extremely rapid, the total quantity of water required is comparatively small. About one tenth of that delivered per minute will be generally sufficient. In this fountain then, we find a great mass of water propelled by the use of only such power as is required to lift it from its normal level through a relatively short space to that from which it overflows and descends as a waterfall or cascade. In that sense it is a radical departure from historic fountains.

The apparatus not only makes the breeding of insects impossible, but is in a sense a very efficient trap.

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Electrical Devices.

TELEPHONE ATTACHMENT.—J. WHITAKER, 4735 Leiper St., Frankford, Philadelphia, Pa. This invention has reference to a means for hanging up the receiver of the telephone when not in use. It is an object of the improvement to provide a means whereby when the receiver is released by the user, the switch arm will be automatically lowered.

Of General Interest.

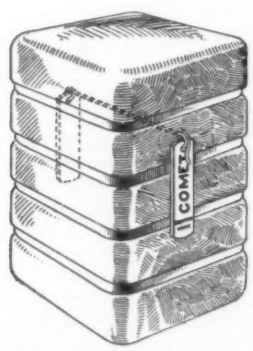
ENVELOP.—P. A. HOFFMAN, Hastings, Minn. This invention has reference to improvements in envelops, and has for an object the provision of an improved structure which will act properly as a closure or document wrapper, while eliminating tapes, rubbers, and other similar fastening means.

INDICATOR.—J. FRAME, Searsport, Maine. The invention relates particularly to indicators for vessels, and has for an object the provision of a structure which will automatically and correctly indicate the amount of "pitching" of a vessel or the amount of tossing of a vessel.

CAN NOZZLE PLUG SEAL.—F. WETTERBERG, care of N. J. Wood Fiber Co., Perth Amboy, N. J. The invention has reference more particularly to plugs for varnish cans, having means which seal the plug in the nozzle of the can. An object is to provide an easily removable plug which has means for sealing the nozzle of the can.

FLOTATION BELT FOR VESSELS.—C. M. BUZUK, 217 Green St., Brooklyn, N. Y., N. Y. The invention provides auxiliary members adapted for disposition in service relation to be inflated; provides flotation displacement at the outside of the hull of a vessel; provides means for protecting flotation members in service relation from drainage due to abrasion or shock; provides means for rapidly and readily covering the flotation members; provides floating means with armor to prevent injury thereto; and provides means whereby the flotation capacity of a vessel may be augmented at will.

FASTENING FOR SHIPPING TAGS.—E. L. WILSON and J. J. REILLY, care of the former, 210 Sip Ave., Jersey City, N. J. This device consists of extending wires or rods through the bale while the latter is being compressed, so that the ends of these wires will project



FASTENING FOR SHIPPING TAGS.

from the faces of the bale in single or in pairs, for the novel attachment of tags which are preferably of such indestructible material as tin, and which are marked to identify the goods. The tags are mounted on both sides of the bale so that the goods can be more readily identified, and it is not necessary to provide any burlap.

Hardware and Tools.

WELL PIPE PERFORATOR.—A. C. GRAHAM, 311 Cherokee Ave., Barttesville, Okla. The invention provides a tool adapted for operation simultaneously at opposite sides of the pipe or casing of a well to produce perforations therein; provides a simplified construction of perforator; and provides for the reduction of friction in the operation of the perforator. The

WELL PIPE PERFORATOR.

engraving shows a vertical section taken on the median line of a perforator, the parts being represented in the out-of-service position they have when being fed into a well.

SASH LOCK.—C. E. JANES, Lynbrook, N. Y. The invention comprises separate sash-locking means separately attachable to upper and lower sashes, and each having a bolt adapted to be projected to engage the window frame, together with actuating means for the bolt, said means including a coupling bar adapted to couple the two sash-locking means when the same are brought into alignment, whereby the bar will form a connection between the two sashes, as a locking means therefor, in addition to the separate locking of the separate sashes to the frame by means of the bolts.

DENTAL TOOL.—F. E. PERKINS, Largo dó Carioca 9, Rio de Janeiro, Brazil. The tool is designed more particularly for the treatment of pyorrhea. It includes a handle and a longitudinally vibratory shaft extending at an angle

DENTAL TOOL.

with respect to the handle and to which the operating implement is attachable, together with means whereby said implement may be adjusted or revolved around a tooth during its vibratory movement by the hand of the operator.

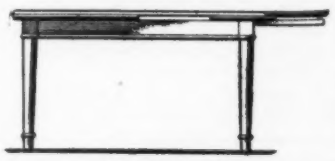
Heating and Lighting.

LAMP CLEANER.—W. D. BOWIE, Bowie, Colo. The object in view is to provide an easily operated cleaner for the gas outlet pipe in miners' carbid lamps. Another is to provide a device easily applied and removed, and also easily and quickly operated at any time for cleaning the gas outlet tube in lamps using calcium carbid.

Household Utilities.

EGG BASKET.—A. E. TRENTOWSKY, St. John, New Brunswick, Canada. An object in view of this invention is to provide an improved basket structure for holding eggs or other articles to be cooked, in connection with the timing device, which may be caused to indicate any desired time so that the eggs or other articles may be properly cooked.

EXTENSION TABLE.—V. F. NEUMANN, New York, N. Y. The table embodies a plurality of sections or leaves which, when not in use, can be pushed in out of the way under the table top. An equal number of leaves are used at opposite ends of the table so that it



EXTENSION TABLE.

can be lengthened at one or both ends. When the length of the table is increased by means of the extension, one or more of the extensions can be used, so that the top can be lengthened at either or both ends to a greater or less degree.

Machines and Mechanical Devices.

TURNTABLE FOR STONEWORKING MACHINES.—F. E. LANG, 41 Hill St., Barre, Vt. This adjustable turntable is designed to economize time and labor in handling stone to be finished under pneumatic surfacing, polishing machines, or under any similar machine that requires an adjustable table for the leveling and squaring of the stone, and the setting of the work at any angle.

SPACING BLOCK.—S. F. KRUPP, Box 1697, Atlanta, Ga. The inventor provides a block of minimum weight, maximum strength, and permits of being placed easily in position on the saw shaft or arbor to accurately space the adjacent saws the desired distance apart and to hold the saws parallel to the plane of rotation to the saw cylinder.

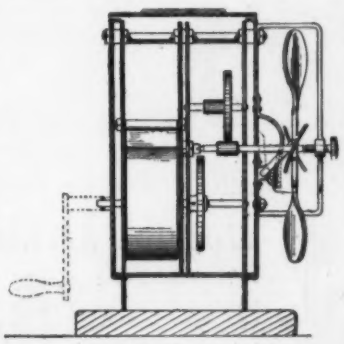
TORSION METER.—T. B. THOMPSON, 2506 Clifbourne Place, Washington, D. C. The invention relates to devices for measuring the torsion of shafts, especially those shafts which are used in marine engines of the turbine type. It provides a device by means of which the amount of torsion developed in a given length of shaft of certain size may be quickly and accurately determined.

ROTARY DRILL BIT FOR OIL WELLS.—W. M. KECK, Coalinga, Cal. The invention has particular reference to means for boring rapidly through various characters of earth or rock. It provides a drill bit, preferably of the fish tail form, adapted to operate rapidly and without clogging through soft, sticky, or shaly rock.

DROP DOWN SMALL ARM.—W. BAKER, 87 Snow Hill, Birmingham, England. The purpose here is to provide an automatic cocking and firing mechanism for drop down guns of the type in which the cocking and hammer levers are mounted on a common pivot. The invention comprises the pivoting on the cocking lever of a pin which passes through or alongside the hammer lever, and the mounting on the said pin of a spiral firing spring.

PUMP.—H. WELLINGTON, deceased. Address Mrs. Louise F. Wellington, 2068 Fifth Ave., New York, N. Y. This invention is more especially designed for use in wells, mines, and other places from which water or other liquid is to be raised to a desired height, is arranged to insure raising of water or other liquid at a minimum expenditure of power, prevents binding of the revolving lifting devices, reduces destructive vibrations and permits removal of the lifting devices for repairs, etc., without disturbing the pump cylinders.

MACHINE BRAKE.—J. C. MCGEE, Grenada, Miss. The object here is to provide a brake especially adapted for use with fans for cooling buildings or for producing currents of air wherever desired, and especially fans driven



MACHINE BRAKE.

by spring motors, wherein the brake is arranged to engage the fan directly, for holding the fan against movement during the winding of the motor, or at any other time, the said mechanism being releasable.

PHOTOGRAPHIC PRINTING MACHINE.—B. O. FJORKENSTAD, Fingal, S. D. The machine is designed especially for printing on developing papers, and the primary object of the invention is to provide for printing on developing paper where speed, accuracy and uniformity of results are desired, whether used with natural or artificial light.

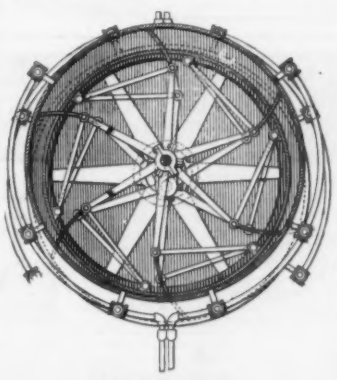
MINE CAR STOP.—J. T. PERO, 1801 Monroe Ave., Scranton, Pa. This invention provides means for arresting the downward progress of an elevator in a mine shaft, the operation of which serves to release, for delivery to the elevator, a waiting car; and provides means for preventing the overrunning of cars into the shaft when the elevator is not in position to receive said cars.

Prime Movers and Their Accessories.

FOUR CYCLE ENGINE.—C. W. SNYDER, 1861 W. 12th St., Los Angeles, Cal. The purpose here is to secure both the scavenging and the cooling of the cylinder, by causing air to pass through the cylinder when the piston is at or adjacent the end of the power stroke, so that when the piston completes its scavenging stroke, the gases remaining in the cylinder will be largely air instead of burned gases.

INTERNAL COMBUSTION ENGINE AND METHOD OF SCAVENGING THE SAME.—C. W. SNYDER, 1861 W. 12th St., Los Angeles, Cal. It is the object of this invention to utilize the vacuum in inducting air from the outside atmosphere into the engine cylinder to scavenge the same prior to the admission of the fuel charge. Air admitted in this manner prevents the return movement of exhaust gas through the exhaust port into the cylinder, it permits the exhaust gas to continue moving out the exhaust conduit, and thus to replace by air a portion of the exhaust gas normally remaining in the cylinder at this time.

ROTARY ENGINE.—S. D. SIMMONS, care of Henry Amling, 4228 Park Ave., Bronx, N. Y., N. Y. This invention has for its object to pro-



ROTARY ENGINE.

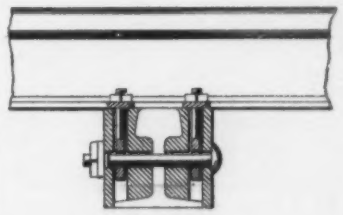
vide a rotary engine having blades extending through slots in a rotatable drum disposed in a casing and eccentric with a shaft, a portion of the casing being eccentric with an adjacent portion of the casing, and the shaft being provided with a crank disposed in the said adjacent portion of the casing.

Railways and Their Accessories.

SHIPPING UNIT.—J. W. TERRY, 32 Augusta St., San Antonio, Tex. This invention refers to a shipping unit or carrier for the transportation of merchandise as freight, express, or baggage, the said unit comprising generally a wheeled structure of predetermined size, a given number of which may be contained in an ordinary box car and transported bodily, to the end that labor and time be minimized in the loading, transportation, and unloading of small consignments.

RAILWAY TRACK.—T. G. MCNEILL, Ludlow, Cal. This improvement relates to a means for holding track rails in a manner to prevent creeping of the track, or of either rail thereof, the rail-holding means, moreover, being formed and positioned to prevent destruction of the same by expansion or contraction of the rails.

RAILROAD TIE.—E. SAMUELSON, St. Peter, Minn. One of the principal objects of the inventor is to provide means adapted to be carried by a cross-tie, for securing the track rails in place on the tie. He provides rail fastening means adapted for use with lengths of worn out rails whereby the latter may be utilized as cross ties. He also provides in combination with a rail length means for engaging the base flanges of the track rail, and means for ad-

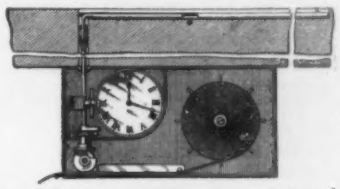


RAILROAD TIE.

justing the rail engaging means both longitudinally and vertically whereby to accommodate rails of various dimensions.

Pertaining to Recreation.

CONTROLLING DEVICE FOR BILLIARD TABLES AND THE LIKE.—L. BERNARD, 73 Third Ave., Manhattan, N. Y., N. Y. This inventor provides a device for billiard tables, pool tables, and similar game apparatus, and ar-



CONTBOLLING DEVICE FOR BILLIARD TABLES.

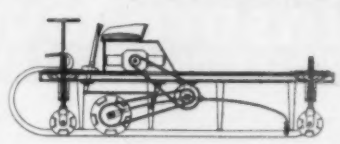
ranged to automatically register the time the apparatus is used during the day or other given period, and also to register the number of games played during such period.

Pertaining to Vehicles.

REAR END SIGNAL FOR VEHICLES.—G. J. WOHLTMANN, 241 61st St., Brooklyn, N. Y., N. Y. The invention provides a signal, the operation of which is simple and concordant with the movement of the hand of the driver or traffic manager, and provides a signal arranged to show, under all conditions, the rear-end or danger light.

PIVOTAL TURNING MEANS FOR AUTOMOBILES.—A. I. MCGLOUGHLIN, care of E. Flagg, 109 Broad St., New York, N. Y. This invention relates generally to a pivotal turning means for automobiles and the like, characterized by a structure permitting the vehicle to turn about a point which is substantially at the middle point of the rear axle.

AUTOSLEIGH.—L. TOWNSEND, 416 Chestnut St., Evansville, Ind. The object of the invention is to provide a strong and inexpensive sleigh which is easily controllable, and on which the traction wheels are so arranged as to prevent sliding sidewise. The means for guiding



AUTOSLEIGH.

the sleigh are adapted to relieve the weight of the sleigh from the runners during the turning of the sleigh. The sleigh can be quickly stopped, the means for this becoming operable when the traction wheel is rendered inoperative.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

INQUIRIES

Inquiry No. 9420. Wanted the name of a concern who can make a glass jar.

Inquiry No. 9421. Wanted to find a manufacturer who can turn out scissors in thousand lots. Special design. Full particulars on application.

Inquiry No. 9422. Wanted the name and address of a manufacturer of a machine which can crack Japanese walnuts whole.

Inquiry No. 9423. Wanted the name and address of a concern that manufactures a product which is light in weight also pliable to the tensity of spring steel in flexibility. The material is wanted in strips varying from ¼ to ⅝ of an inch in width and from 4 to 8 inches long and 3-32 to 1-16 of an inch in thickness. Vulcanized rubber would answer the purpose provided it could be made to bend.

Inquiry No. 9424. Wanted the name and address of a manufacturer who can supply paper twine and what is known as cardboard strip.

Inquiry No. 9425. Wanted the name and address of a manufacturer of supplies for model aeroplane and boat builders.

Kammerlingh Onnes

(*Concluded from page 151.*)

the laboratory has been a generous and open one. Investigators of the world are welcome. They are received cordially, the director discusses with them their ideas, he lays out a course of investigation, then the apparatus is prepared by the laboratory, and the foreign specialist and Onnes together work out the results. This planning lays at the feet of the investigators of the world the best means for their experiments, it conserves effort and equipment, and it secures to the Cryogenic Laboratory a share in whatever may be done, and places the publication of the descriptive papers in the proceedings of Dutch societies.

Denmark preserves the name and fame of the dead Thorwaldsen in a collection of his statues, and he who would study the originals by the great master must go to Copenhagen to find them. Leyden is erecting a similar memorial to Onnes while he lives by making itself the focus of cryogenic research, and he who would know of the story will learn it from Dutch publications—in English if he will—and the important work is practically retained in Dutch hands.

It is only natural, therefore, that Onnes should have had as co-workers with him in his laboratory an important number of the world's strongest specialists. He has experimented together with Madame Curie in radiometry at the world's lowest attainable cold, and with another woman specialist, Miss T. C. Jolles, in the intricacies of the van der Waals problems. With the two Becquerels he has discussed the phosphorescence of uranyl and other salts, and with Jean Becquerel alone the behavior of certain rare earths. With Zakrewski as early as 1894 there were undertaken some of the van der Waals researches and the determination of the co-existence of both vapor and liquid states of gases at very low temperatures. With Lenard and Pauli, Onnes investigated other uncommon minerals, and with Weiss some deep questions of magnetism, which resulted in the "magneton" hypothesis. Methods of measuring under the new order of things were undertaken with C. Braak in 1909 and with Clay; then with Crommelin of his own university various technical data were secured of argon, oxygen, and other gases, four or five papers being needed to present the results. With two compatriots further work was undertaken in 1912, de Haas making some measurements on hydrogen and Oosterhuis a set of observations on paramagnetism. Perrier worked at Leyden in magnetism, resulting in four papers; Dr. Hyndman tested various forms of instruments; Bondin was associated with the laboratory in work on hydrogen. Kesson was another foreigner, and very recently Bengt Beckman has taken up the Hall phenomenon, which considers the effect on a current when the conductor is placed in the field of a magnet. And these items enumerated are but a skimming of the collaborative work.

It is to be remembered that during all this time dozens of researches were conducted by Onnes with no other help than the laboratory force. These cover every phase of the condition of gas at low temperatures, viscosity, volume, vaporization, temperature and tensions and of many solids, and include numbers of collateral investigations of conductivity, condition and change, with full consideration for general hypotheses and special suggestions. The reports of the investigations are voluminous and somewhat scattered, although kept pretty well within the proceedings of the Amsterdam Academy and other scientific societies of Holland. At the same time, for the convenience of the scientific world, Onnes has brought together abstracts of the principal papers in a set of volumes that will readily fill a three-foot shelf. More than two hundred papers are represented in these abstracts, of themselves a monument to the activity of the laboratory.

In all this it is to be remembered that Onnes has been busy in his corner of science for the benefit of knowledge, and save in a rare spectacular moment like that of liquefying helium, has kept out of the "spotlight" of popular publicity. He has been thus practically unknown to the people and even to workers in other branches of science. He has been doing this for thirty years, actuated by the most classic of motives. The world rejoices, therefore, that distinction has sought him out, the splendid reward of merit that the Nobel prizes imply. All honor to Onnes, diligent and productive worker in an unheralded section of science.

Hydraulic Fill Dam for an Earthquake Region

(*Concluded from page 154.*)

the dam is borrowed from the hillside adjacent and from the valley floor of the reservoir site, the material lowest in elevation being placed in the base of the dam. The material is excavated by means of hydraulic jets with nozzles ranging from 1¾ inches to 5 inches in diameter and with a pressure of from 60 to 80 pounds at the jet. Groups of small nozzles are attached to a 4-inch hose for work in the lighter material, so that moves may be made quickly. But for the more difficult material, two great monitors are employed, and it takes from half a day to a day to move these giants into new positions.

As the material is excavated it is carried in suspension down to a sump, where it is picked up by 12-inch centrifugal dredger pumps and carried to either toe of the dam. The material discharged at the toes runs toward the center of the dam, where a pond is maintained at the desired height. The large gravel stops at the toe, and the water graduates the material in fineness as it approaches the central pond. Thus, in this pond only clay is deposited, forming a water-tight core for the dam, the thickness of which is regulated by the central pond. During the period of low water, the surplus water from the sluicing is returned above the dam for re-use after it has deposited its load of material.

At the intake of the culvert a reinforced concrete intake tower is being built. This will be tapered, having an internal diameter of 19 feet at the bottom and 10 feet at the top. This has been especially designed against forces due to earthquakes, a matter of considerable importance in view of the fact that the dam itself is located about half a mile from a very large fault.

When the dam is completed it will provide a reservoir of 1,833 acres with an average depth of 88.7 feet, having a tributary catchment area of 100 square miles, which may be extended later to 140 square miles. The catchment area ranges from 800 feet above sea level, which, of course, is the elevation of the dam, to 4,000 feet, and has an average normal precipitation of about 28 inches per season. The capacity of the reservoir will be 53,000,000,000 gallons at flow line.

We are indebted to Mr. F. C. Herrmann (who, with Mr. William Mulholland, designed the dam) for the photographs here reproduced.

Doing Without Europe

(*Concluded from page 157.*)

assume that the yield of potassium chloride could be made to surpass the entire present consumption of potash salts in this country. Counting in Alaska the annual yield might possibly be several times this amount. But there are a number of factors not yet sufficiently well known or understood to make possible any more than tentative estimates."

A characteristic of the "potash from kelp" propaganda is that large capital is quite unnecessary. A very modest outlay for harvester, dryer, and working capital is required.

That a large growth of kelp exists, capable of producing an enormous tonnage of potash salts, has been demonstrated. It has also been demonstrated that kelp can be harvested and prepared for market at a cost commercially practicable. A business in kelp actually exists, though small. It remains to be proven that a stable business, capable of meeting the national necessities, can be established, and to this

Kammerlingh Onnes

(*Concluded from page 151.*)

the laboratory has been a generous and open one. Investigators of the world are welcome. They are received cordially, the director discusses with them their ideas, he lays out a course of investigation, then the apparatus is prepared by the laboratory, and the foreign specialist and Onnes together work out the results. This planning lays at the feet of the investigators of the world the best means for their experiments, it conserves effort and equipment, and it secures to the Cryogenic Laboratory a share in whatever may be done, and places the publication of the descriptive papers in the proceedings of Dutch societies.

Denmark preserves the name and fame of the dead Thorwaldsen in a collection of his statues, and he who would study the originals by the great master must go to Copenhagen to find them. Leyden is erecting a similar memorial to Onnes while he lives by making itself the focus of cryogenic research, and he who would know of the story will learn it from Dutch publications—in English if he will—and the important work is practically retained in Dutch hands.

It is only natural, therefore, that Onnes should have had as co-workers with him in his laboratory an important number of the world's strongest specialists. He has experimented together with Madame Curie in radiometry at the world's lowest attainable cold, and with another woman specialist, Miss T. C. Jolles, in the intricacies of the van der Waals problems. With the two Becquerels he has discussed the phosphorescence of uranyl and other salts, and with Jean Becquerel alone the behavior of certain rare earths. With Zakrewski as early as 1894 there were undertaken some of the van der Waals researches and the determination of the co-existence of both vapor and liquid states of gases at very low temperatures. With Lenard and Pauli, Onnes investigated other uncommon minerals, and with Weiss some deep questions of magnetism, which resulted in the "magneton" hypothesis. Methods of measuring under the new order of things were undertaken with C. Braak in 1900 and with Clay; then with Crommelin of his own university various technical data were secured of argon, oxygen, and other gases, four or five papers being needed to present the results. With two compatriots further work was undertaken in 1912, de Haas making some measurements on hydrogen and Oosterhuis a set of observations on paramagnetism. Perrier worked at Leyden in magnetism, resulting in four papers; Dr. Hyndman tested various forms of instruments; Bondin was associated with the laboratory in work on hydrogen. Kesson was another foreigner, and very recently Bengt Beckman has taken up the Hall phenomenon, which considers the effect on a current when the conductor is placed in the field of a magnet. And these items enumerated are but a skimming of the collaborative work.

It is to be remembered that during all this time dozens of researches were conducted by Onnes with no other help than the laboratory force. These cover every phase of the condition of gas at low temperatures, viscosity, volume, vaporization, temperature and tensions and of many solids, and include numbers of collateral investigations of conductivity, condition and change, with full consideration for general hypotheses and special suggestions. The reports of the investigations are voluminous and somewhat scattered, although kept pretty well within the proceedings of the Amsterdam Academy and other scientific societies of Holland. At the same time, for the convenience of the scientific world, Onnes has brought together abstracts of the principal papers in a set of volumes that will readily fill a three-foot shelf. More than two hundred papers are represented in these abstracts, of themselves a monument to the activity of the laboratory.

In all this it is to be remembered that Onnes has been busy in his corner of science for the benefit of knowledge, and save in a rare spectacular moment like that of liquefying helium, has kept out of the "spotlight" of popular publicity. He has been thus practically unknown to the people and even to workers in other branches of science. He has been doing this for thirty years, actuated by the most classic of motives. The world rejoices, therefore, that distinction has sought him out, the splendid reward of merit that the Nobel prizes imply. All honor to Onnes, diligent and productive worker in an unheralded section of science.

Hydraulic Fill Dam for an Earthquake Region

(*Concluded from page 154.*)

the dam is borrowed from the hillside adjacent and from the valley floor of the reservoir site, the material lowest in elevation being placed in the base of the dam. The material is excavated by means of hydraulic jets with nozzles ranging from 1¾ inches to 5 inches in diameter and with a pressure of from 60 to 80 pounds at the jet. Groups of small nozzles are attached to a 4-inch hose for work in the lighter material, so that moves may be made quickly. But for the more difficult material, two great monitors are employed, and it takes from half a day to a day to move these giants into new positions.

As the material is excavated it is carried in suspension down to a sump, where it is picked up by 12-inch centrifugal dredger pumps and carried to either toe of the dam. The material discharged at the toes runs toward the center of the dam, where a pond is maintained at the desired height. The large gravel stops at the toe, and the water graduates the material in fineness as it approaches the central pond. Thus, in this pond only clay is deposited, forming a water-tight core for the dam, the thickness of which is regulated by the central pond. During the period of low water, the surplus water from the sluicing is returned above the dam for re-use after it has deposited its load of material.

At the intake of the culvert a reinforced concrete intake tower is being built. This will be tapered, having an internal diameter of 19 feet at the bottom and 10 feet at the top. This has been especially designed against forces due to earthquakes, a matter of considerable importance in view of the fact that the dam itself is located about half a mile from a very large fault.

When the dam is completed it will provide a reservoir of 1,833 acres with an average depth of 88.7 feet, having a tributary catchment area of 100 square miles, which may be extended later to 140 square miles. The catchment area ranges from 800 feet above sea level, which, of course, is the elevation of the dam, to 4,000 feet, and has an average normal precipitation of about 28 inches per season. The capacity of the reservoir will be 53,000,000,000 gallons at flow line.

We are indebted to Mr. F. C. Herrmann (who, with Mr. William Mulholland, designed the dam) for the photographs here reproduced.

Doing Without Europe

(*Concluded from page 157.*)

assume that the yield of potassium chloride could be made to surpass the entire present consumption of potash salts in this country. Counting in Alaska the annual yield might possibly be several times this amount. But there are a number of factors not yet sufficiently well known or understood to make possible any more than tentative estimates."

A characteristic of the "potash from kelp" propaganda is that large capital is quite unnecessary. A very modest outlay for harvester, dryer, and working capital is required.

That a large growth of kelp exists, capable of producing an enormous tonnage of potash salts, has been demonstrated. It has also been demonstrated that kelp can be harvested and prepared for market at a cost commercially practicable. A business in kelp actually exists, though small. It remains to be proven that a stable business, capable of meeting the national necessities, can be established, and to this

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It's simply this: that Studebaker MAKES SURE.

—and makes sure not only in the manufacturing that goes on in the gigantic plant at Detroit, but also in the running of the car on the roads AFTER it is in your hands.

For example, you may never need a front axle forging so strong that it can be TWISTED 3 TIMES without even showing signs of fracture. But if the emergency ever arises, it is there in the car. For Studebaker has MADE SURE.

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For it is Studebaker's ideal not only to manufacture a car as GOOD as any car possibly CAN be—but also to insure that car's giving to its owner EVERY-day service and freedom from expense and full money's worth of pleasure for every dollar of the price. And so Studebaker MAKES SURE of Service—and day by day is dotting the country with new Service Stations—building up a National Service organization of Studebaker Branches and Studebaker Dealers and Studebaker Service Stations so COMPLETE that wherever you drive you are "never more than a town away from Studebaker Service."

And the reason for it all is simply "—because it's a Studebaker"—because this car carries a name that for 63 years has stood for the highest achievements in vehicles of every nature—a name that has come to be a PROMISE to the buyer of honesty of manufacture AND day-after-day service.

And so not only in the matter of giving Service to Studebaker owners, but in every little detail of manufacturing, you find this Studebaker policy of MAKING SURE the buyer gets FULL money's worth

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LIGHT

for example, a most delight
PENSIVE car to run. For Stude
sure of the car's safety, have disregarded
freely that while the SIX is far stronger, it is als
so, LOWER in upkeep cost.

But the only thing to do is to see this SIX at y
see with your own eyes what Studebaker, with
sources and ideals of manufacture, has been abl
today, too, write for "The Story of Studebaker."

STUDEBAKER, DETROIT — Canadian

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Electric Lighting and Starting—FULL Floating Rear Axle—Timken Bearings—Safety Tread Rear Tires—One-man Type Top.

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Studebaker LIGHT SIX . .	1385	1750
Studebaker SIX (7-passenger),	1450	1825

F. O. B. Detroit

end should be lent all possible assistance from Federal and State governmental activities and private enterprise.

The Farmer is Helped by the Government. Why Not the Metal Manufacturer?

If the industries dependent on German potash are likely to benefit from the scientific work which the Government has done to develop a potash industry at home, it is due not to any lively interest in the welfare of the manufacturer as in the prosperity of the farmer. American farmers have received practically everything they have demanded from Congress. They are exempt from the operation of the anti-trust laws; they may form combinations for their own benefit, establish co-operative selling organizations and may legally employ most of the devices of the old trusts. Thanks to liberal appropriations our Department of Agriculture has become the largest organization of its kind in the world. Millions are spent annually in teaching the farmer everything that he ought to know, from building fences and raising pigs to the scientific application of Mendel's laws of heredity and the best way of plowing by machinery. This is as it should be. The work of the Department of Agriculture would be a credit to congressional foresight were it not more a tribute to political astuteness.

The United States an Undefended Treasure Land

(Concluded from page 159.)

equipment. On the contrary, every effort should be made to secure, even at a somewhat added cost, manufacture of field guns, ammunition, small arms and equipment, by outside firms, so that, in case of any sudden emergency, there may be agencies other than the arsenals which have the machinery and, what is equally important, the trained *personnel* to meet the needs of the Government. No economy can be more unwise than that which concentrates in the hands of the Government the entire manufacture of articles of military equipment, and no policy will tend more to establish a condition of inability to meet the demands of war than such a one.

We Have Practically No Reserve of Uniforms, Tents, Transportation Equipment and Other Military Supplies.

In other departments (uniforms, tentage, etc.) we are practically without a reserve of materials, worthy of the name, considering the demands which must be met, and met promptly. We have no ammunition trains, no general reserve of transportation or other military supplies, and no adequate plans to supply them. All this is being left to be prepared in the hurry and confusion of war.

That "Undeveloped Military Resources" Fallacy.

Our people are prone to speak of our undeveloped military resources. These are of value if we have time to develop them, but in the onrush of a modern war are of little more value than a deep-lying coal vein to a freezing community in a Nebraska blizzard, and reference to them as a military asset of value, when it is remembered that all our possible enemies are dangerous enemies and prepared to the minute, is just about as intelligent and as much appreciated by those who understand what preparation means, as would be advice to the freezing people to use the unmined coal one hundred feet under their feet.

Wars Are Sudden, and the Ocean Renders Attack Easy and the Point of Attack Doubtful.

Wars in these times come with great suddenness. The ocean, instead of being a barrier, is one of the readiest and most convenient means of approach. We have an enormous coast line unprotected, except at the mouths of our harbors, and even these are unprotected against an enemy who lands outside the range of their guns.

We Have Only One Half of the Force Necessary to Man the Coast Fortifications With Even One Relief.

The existing regular coast artillery force, even with the existing reserve coast artillery militia, is entirely insufficient to man the existing works and give even one relief. Indeed, these forces combined amount to but little more than one half the force necessary to accomplish this. The idea has been advanced that the coast defenses could be adequately manned by a judicious transfer of *personnel* based upon an enemy's movements. This is, of course, absurd. As the attack would come from the sea, the whereabouts and movements of the enemy would be unknown, and once off the point of attack there would be no opportunity through judicious transfer of troops to meet the attack until several days after it was finished. No, quite the contrary is the policy which must be followed. In time of war all fortifications on the sea coast of the ocean over which the enemy will operate must be completely manned, and with a full supply of ammunition. Any other policy is lacking in appreciation of the needs of the situation. If the attack involves both oceans, then the entire sea coast of the United States will have to be maintained in a condition of defense, and an adequate force of men and supply of ammunition will be required in every work.

It must be remembered that our expensive system of sea coast fortifications will be practically useless as a means of defense unless supported by an adequate mobile force. The term "coast defense" is a misnomer and conveys to the general public a false impression. It is only an element of defense, and unless supplemented by a mobile force will be of little value in preventing an invasion of the country. It may prevent bombardment of harbors and towns behind them by fleets, but never can, without the mobile army, prevent the more serious feature of war, namely, territorial invasion and occupation. Sea coast fortifications will not prevent an enemy from landing on our shores and seizing and occupying what he wants; this can only be prevented by an adequate mobile force. We have no such force.

We have a miniature fighting force, a population unused to arms, without organization, filled with an enormous conceit as to their military ability, which is unjustified by history. The question is, What shall be done to better the present situation?

The Urgent Need of the Hour.

In the first place, we must provide a reserve behind the regular army and militia as above indicated, and provide the regular army and the militia with the organizations necessary to complete them, and also provide the necessary field artillery guns and ammunition, ammunition trains and other supplies which cannot be promptly procured in the open market. It is probable that the States will feel with reference to the reserve and to the special arms, such as cavalry and field artillery, that these are for national uses and must be supplied and maintained by the Federal Government. So be it. If the States are not able, they must be helped. Without these vitally important organizations, neither the regular army nor militia will be efficient. Artillery has become such a dominant feature in the modern battle field that to send troops into campaign without a proper proportion of this arm would be suicidal. Any nation which neglects to provide this important, nay, vital arm, in liberal proportion, courts disaster and wantonly wastes the lives of its people.

In fact, troops without artillery are, against troops provided with this arm, no better off than if armed with spears, until they get within a range of 1,200 yards.

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